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TROUT AND TROUT WATERS

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Trout and Trout Waters

BY

LANCELOT R. PEART

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Preface

As its title infers, this is a book about trout and the waters in which they live.

Its object is an attempt to put into perspective the present-day picture of trout-fishing: to try to show why fishing has deteriorated over the years; to indicate the types of water in which trout will thrive and those in which they will not; to show how waters may be used to best advantage; and to write something about the management of trout fisheries.

While, in the main, this has been a labour of love, it has also been a labour of some years duration and has had to be fitted into an already busy life. Having rushed into print in book form in my early 'twenties' and again before reaching the age of thirty, I found that it was necessary to do a lot more work and gain considerably more experience before I should have anything additional worth publishing. Consequently, seventeen years have passed, during which period many of the ideas presented here have gradually simmered and matured.

While I claim a considerable degree of originality for this book, it would be immodest in the extreme to confess to no debt to ideas put forward by other workers during the past half-century and more, as anyone, who has read widely in a particular subject, should be the first to admit. Very little reference to other books has, however, been made in the compilation of the present one. This is, perhaps, a good fault, since plagiarism tends to be a besetting sin among writers on angling subjects. At the same time, I have felt it obligatory to include a bibliography at the end, which contains a list of publications valuable in themselves and inestimably valuable to me, during past years, as instruments serving to stimulate thought and imagination. Many views expressed by me will not, fully, or even partly, coincide with those of other writers ; some may not materially differ.

As one whose advice on the development and management of trout fisheries is not infrequently sought on a professional basis, some readers may well be tempted to suggest, that by writing this book, I am out to grind an axe. It would be idle to deny completely that this is so. On the other hand, the axe is smaller than the uninformed might be led to imagine. My belief and hope that the axe's edge is clean and relatively free from nicks, must be left for the reader to decide.

It has been my privilege to have had quite exceptional opportunities for meeting interesting people, also interested in trout, and to have visited, in one capacity or another, countless waters all over Britain. At the same time, the life is full to the brim with toil and not without its worries. Nevertheless, no way of life, that I can easily imagine, could be more pleasant. In brief, my work is also my pleasure and, for that blessing, I can never be sufficiently thankful.

Mill Hatch
Hungerford
Sept., 1955

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CHAPTER 1

On Reasons for the Deterioration of Trout Fishing

Capital depreciation for 500 years. Angling has been practised as a sport in Britain for at least five hundred years. Yet, until about one hundred years ago, there was little or no attempt at conservation.

Trout have innumerable enemies at all stages of their existence, man, directly and indirectly, being one of the most deadly of all the predatory animals attacking trout.

During the past century, realisation has dawned that fishing for trout cannot be carried out on an unlimited scale, without serious effects on the stocks of trout in our waters. It is, however, quite impossible for Nature to carry the burden of replacement and, as a result of continued intensive fishing, stocks of wild trout are gradually, but steadily, being diminished.

Number of Anglers. Some authorities put the total number of anglers of all kinds as high as 2 millions. This is probably an exaggeration, though the number may well lie between 1—2 millions. Coarse fish anglers account for the major proportion of the total, but there are certainly some hundreds of thousands of trout fishermen. Every year their numbers appear to increase.

Depletion of stocks of Trout. The number of waters containing satisfactory stocks of wild trout is very few. These are mostly in private hands and fished comparatively lightly. Where waters are heavily fished—and such waters are in the majority—stocks of trout have gradually been reduced.

Popularity of Angling. Trout fishing has become an immensely popular sport and more and more people want to fish with the coming of every spring. Trout fishing is popular because it exercises both mind and body, requires skill, perseverance and intelligence. It also meets a deep-down primitive instinct. One reason for the great increase in the popularity of fishing is its cheapness in relation to sports like hunting and shooting. Since the last war, the cost of these great sports has risen, proportionately, much higher than that of fishing.

Scarcity of good water. Good water is scarce, largely because there are too many anglers fishing for too few trout. The only waters, where fishing is good or satisfactory, are carefully-guarded private waters, exclusive club, or syndicate waters, or waters sufficiently remote for large numbers to have the time or money to reach them.

The effect of modern transport. The railways, gradually spreading steel arteries all over the country, made the first big contribution (excepting pollution) to the scarcity of good trout fishing. Anglers were able to go further afield and to spend more time fishing. More and more anglers were attracted to the sport, owing to the ease with which distant waters could be reached. The motor-car continued the process even more decisively. Few anglers would now be able to find the time, or the inclination, to fish, unless they had some rapid means of transport. Few waters within reach by rail, or road, have not, by now, been exploited to the full.

More leisure. The reduction in working hours, a process which is still going on, has meant more hours of fishing by more men, with a consequent strain on the natural resources of all our waters.

Fishing Pressure. As a result of a combination of circumstances, fishing pressure—the number of anglers fishing a given area in a given period—has become very high. Short of some catastrophe to a major proportion of the population of these islands, it is a problem likely to increase rather than to recede. A return to the days of fewer anglers and bigger catches is quite impossible. The only remedies are to make the best possible use of all available water, to try to salvage those waters which have been rendered unfit for trout, and to provide more trout for the angler to catch at the lowest possible cost.

Relaxation and Fishing. In these days of stress and strain in domestic and international affairs, together with the wear-and-tear of the daily round, some form of satisfying relaxation has become even more necessary. Human beings are ill-equipped for the pace of modern life : hence the neurotics, hypochondriacs and 'ulcer' men. It is, therefore, essential that those, who find in fishing an anodyne for the cares of the world, should continue to be able to do so. That more people are finding, in fishing, a source of refreshment and relaxation is another load for the fisheries to bear.

Sharing fishing round. While it is clear that the best possible use should be made of all fishable water, it is folly to suggest that fishing should be thrown-open to all and sundry. This plea is occasionally made in the angling press ; but it is one based on ignorance, usually being put forward by someone who has not bothered to consider the implications of such a suggestion. It is very desirable that as many anglers as possible should be able to enjoy trout-fishing worthy of the name. But, as already stated, there is a scarcity of water in relation to the number of fishermen. Anglers are increasing in numbers annually, whereas water suitable for trout-fishing is, for one reason and another, tending to decrease. It is necessary to remember, that almost every water now worth fishing, is only worth fishing, because someone, or some body of persons, has lavished labour, love and money upon it. It is horrible to contemplate what would happen were all fishing to be made completely public. All the best waters would immediately become the focal-point for bus-loads from afar. Like locusts they would take their fill and then move on to the next-best water. So the awful process would go on. There is little doubt that the control of fishing by a central authority in Whitehall would mean—assuming a licence charge within the reach of the majority—that in a very few years trout-fishing throughout the country would be uniformly hopeless.

Distribution of wealth. The rich are fewer in numbers and so heavily taxed that they are no longer rich. Those in poorly-paid occupations in the past are now, relatively, well-to-do. The working-man is now in a position to spend a higher proportion of his earnings on pleasure and fishing has shared heavily in his increased spending. Unfortunately, this expenditure on fishing (largely on tackle and fishing-permits) has materially aided the process of depleting our stocks of trout. The rate at which trout are killed is invariably greater than the rate of natural or artificial replacement. This applies to the majority of waters. The more expensive waters, owned or fished by some thousands of anglers from the middle and upper strata of society, are very much in the minority. Quality of sport in them is maintained only at considerable expense. Fewer people are now able to meet these rising expenses. Hence more and more water gets into the hands of fishing-clubs with low subscriptions and large memberships, to the further reduction of stocks of trout.

Better Tackle. Great improvements in the quality and design of tackle during the last fifty years have given a definite bias in favour of the angler in his pursuit of trout. Rods, reels, lines, flies and every other item, conceivably of use to the angler, are produced in large quantities by up-to-date mass-production methods. The thread-line outfit—effective, deadly, compact, easy to use and easy to carry—has, doubtless, helped considerably to reduce stocks of trout wherever it is allowed. The use of the nymph on dry-fly streams has made it possible for a man to keep hammering away all day, frequently enabling him to catch trout which would, otherwise, have lived to grow older and larger. Outboard-motors, frequently seen on large trout-lochs in recent years, enable at least three times the number of drifts to be made in a day and have taken the backache out of boat-fishing and meant more trout in the boat at the end of the day.

Better technique. The standard of fishing is, undoubtedly, rising continually. Anglers are keen to learn the latest techniques. The angling press puts out a perpetual spate of hints and advice on how to catch fish, more easily and more often, under every conceivable set of conditions. Anglers, as a result, are too keen and too clever. They are tactically well prepared to deal with any trout that swims.

Less water per rod. The combination of a number of circumstances, some of which have already been mentioned, has, inevitably, meant that the number of anglers per mile or acre of water, becomes higher with every passing year. Less water per rod, assuming that no resort to artificial stocking be made, means fewer trout per rod-day and a rising cost to the angler per pound of trout-flesh.

Pollution. Pollution has long been recognised as a menace, not only to fishing, but to public health and amenities. Many learned men, associations, scientific bodies, commissions and so forth, have devoted years of study to the problem. Many hundreds of thousands of words, deploring the effects of pollution, have been written in the Press, in scientific reports and in books and pamphlets. In the meanwhile, pollution is tending to increase and a large number of waters is so badly polluted that fish cannot live in them at all. Of the remainder, it is true to say, that most would be improved from the fisherman's point of view, if the existing pollution could be removed. It is doubtful whether 5 per cent. of the waters in this country are entirely free from pollution.

A good deal has already been done by way of legislation to try and remedy the situation. But there are immense difficulties of a technical, financial and political nature to be solved, before any substantial check to pollution is possible, let alone any significant improvement in the fishing.

Recent valuable work in the fight against pollution has been done by both the British Field Sports Society and the Anglers' Co-operative Association. The best long-term hope for making room for the ever-increasing number of anglers, is in the solution of the pollution-problem and the rehabilitation of the hundreds of miles of river now entirely devoid of fish.

Drainage. Unfortunately, the requirements of land-drainage and the conservation of trout-fishing are rarely similar. A stream that is satisfactory from the drainage point of view is seldom of much value for trout-fishing. The converse is also generally true. Many streams, formerly excellent trout waters, have been so altered in character by removal of gravel, aquatic vegetation, riverside herbage and trees (we have no objection to the removal of pots-and-pans and old perambulators) as to render them quite unfit for trout-fishing of a quality comparable with the period prior to the dredging. Waters rise and fall more rapidly, becoming raging torrents in wet weather and sluggish ditches during periods of drought. The species of vegetation and animal life, formerly present, are often incapable of withstanding these new conditions and a completely new type of flora and fauna frequently appears. Most fishermen must be able to think of examples of streams and stretches of river altered in this way. Streamy, gravelly waters, weed-bedded with celery and crowfoot, in which they had been accustomed, through the years, to catch fat trout, have now become straight-sided, high-banked, canal-like, weedless, or choked with pond-weeds, and, instead of the trout, occupied by shoals of chub or dace, for which the changed conditions appear to be eminently suitable. Occasionally, certain stretches of trout stream—usually above mills or weirs—are materially improved by dredging, but, for the most part, deterioration of the fishing has been all too obvious.

Decay of water-meadows. In the south country—or more particularly in the south country—trout-fishing has suffered appreciably as a result of a gradual deterioration of the water-meadows. Developed largely during the fourteenth and fifteenth centuries, these meadows were kept in first-rate order for several hundreds of years, irrigation-ditches, carriers and channels being kept open and free from silt and rushes. For every mile of main stream, there were, in many cases, three or four miles of carriers, which not only provided fishing at certain times and to a limited extent, but, more especially, were great reservoirs for the breeding of natural food. The productivity of a river, possessing an elaborate water-meadow system, must have been raised many times as a result. During the last sixty years or so, their decay has been rapid. The cow has displaced the sheep. Ditches, carriers and drains have all been trodden-in and become overgrown with rushes and blocked with mud. Few are now in a usable state. No statistics are available and the actual loss is impossible to measure, except by the bitterness of anglers old enough to remember.

Apathy of public. Even though numerous, anglers are vastly outnumbered by those who do not fish. Well over 95 per cent. of the population would hardly know the difference between a trout and a herring and care little or nothing for the state of our rivers. Even anglers are very loath to make a tangible move in support of organisations trying to do their best to improve conditions. It takes a real crisis to whip-up enthusiasm sufficiently for them to offer a modest half-crown for fighting a hostile Bill, and, after success is narrowly achieved, further support is frequently withdrawn. If anglers and sportsmen, generally, will not take adequate steps to safeguard their sports, how then can the general public be blamed for apathy ?

Urbanization of rural areas. Development is rarely static and then only for brief periods during wars and similar national emergencies. The populations of small country towns and villages are rising more, in proportion, than the larger towns and cities. This has brought a demand for all public services, such as light, water and sanitation. These services always lag well behind the demand. Few small country towns are now without a factory or two and there is a general tendency (partly for reasons of safety in the event of another war, partly so as to try and tap cheaper labour) for many light industries to move out into the country. Fishing, in these areas, is usually affected (for reasons covered by other notes in this chapter) and the effects are always adverse to fishery interests.

Increase in population. The population of these islands is now about 53 millions. When fishing first started as a sport, well before the time of the first census, the population was believed to be under 4 millions. Even 80 years ago, when the effect of fishing-pressure was just beginning to be felt, the population was only some 31 millions. No wonder that the angler of today is prone to grumble about the scarcity of good water and the poor sport obtainable at a reasonable price.

The demand for public water supplies. The demand for public water supplies is another serious threat to the existence of many trout waters. The average householder tends to give no thought as to how his water is obtained, nor from where it comes, just as long as the taps gush freely at his touch.

All freshwater supplies are, in the first instance, completely dependent upon rainfall. They are, further, dependent upon that rainfall being conserved, by nature, in the ground, by reservoirs, or natural lakes, by river-systems, ponds and, finally, the water-butt in the cottage garden. Nature is made to give up her reserves of water by tapping springs, sinking wells and by borings of various sizes and depths. Reservoirs are usually constructed in the most favourable areas for obtaining water of the desired quality and where the catchment area is as large as possible in relation to the size of the reservoir itself. By collecting the water from these large areas and piping it away (sometimes for a hundred miles or more) a river, or a series of rivers, may seriously be deprived of its rightful flow. Pumping from borings is continually on the increase and numerous examples could be given of their effect on the flow down the rivers in whose valleys, or watersheds, they are situated. The effect is particularly noticeable in years of drought, or following a cycle with less than the average amount of rainfall. Water is often taken—though seldom for domestic purposes—direct from a river and is used for a multitude of industrial processes. Some of this water (invariably inferior in quality) is returned ; but much is permanently lost.

It is natural (and this natural desire has been politically exploited) that every cottage and house in the country should desire a piped water-supply and water-borne sanitation. Doubtless, in time, they (or their successors) will obtain their wish. But without some new technique, both for obtaining water and for disposing of it, the outlook for fishing interests is by no means bright. To the angler, it is of paramount importance that a solution should be found. Without water in adequate quantity and of satisfactory purity his sport must die out.

Fish production capacity of a water is limited. Just as an acre of grassland can only support a limited number of livestock, or an acre of arable only produce a certain weight of grain, so is the capacity of water to produce fish, limited by similar kinds of factor. Some waters are more productive than others. Trout waters are, in general, far less productive than many authorities suppose, much of the available information being drawn from Continental sources, where production of fish (more especially carp) up to 400 lbs. or more to the acre is not unknown. It is doubtful whether the very best waters in southern England are capable of producing more than 100 lbs. of trout to the acre and, in many British waters (famous ones among them) the annual rod-catch of trout is not more than 20 lbs. per acre and sometimes very much less. It is certain, in any case, that no water in this country can stand up to heavy fishing indefinitely, without a gradual fall in the number of pounds of trout per rod, even though the total overall production of trout-flesh may remain more or less constant.

Difficulty in providing enough takeable trout. Most trout fisheries have a size-limit. Most of them find it increasingly difficult to maintain that size-limit and, at the same time, keep their anglers reasonably happy. The answer is, of course, that the rate at which trout are being caught and killed is in excess of the capacity of the water to replace. The usual remedy is to raise the size-limit, reduce the number of trout which may be killed, or limit the number of anglers. None of these methods is popular. By doing everything possible to increase the productivity of a water and by stocking with trout approaching the legal size, more trout can be killed and more anglers accommodated in a given area or length of water. This is the way in which most progressive fisheries are tackling the problem of over-fishing.

Trout do not get time to grow. Even under the best conditions, trout do not make spectacular growth. The average south-country trout of one pound in weight is at least three years old and may, often, be older. In many parts of the country, a one-pound trout is anything up to ten years old. A trout is seldom worth catching at under three years of age, even in the best waters and, in many waters, most of the takeable trout are five or six years old. Trout are, therefore, by no means easily replaced and the greater the fishing-pressure—something not catered for by Nature—the less easy does replacement become. It is a rather solemn thought that every time a trout of a pound in weight is killed, three years work, by God, man and fish, is also being destroyed.

A shortage of keepers and bailiffs. The cost of wages has risen by about 300 per cent. since 1939 and the resultant increase in expenses has caused many owners and others to cut down staffs. Even now, no one will grudge the keeper his wages ; but an additional heavy burden has been thrown upon the sport of fishing and substantially raised its cost.

Increase in vermin. The inevitable result of fewer keepers has been that vermin of all kinds has increased. The enemies of trout are too numerous to mention here. Fur, feather and fin are, however, abundantly represented. All these predators are increasing, due to the high cost of keeping them under control. As a direct result, stocks of trout have been decimated and catches steadily diminish.

The waters of Britain are under-developed. In spite of the great interest taken in trout-fishing and of the fact that fishing has been going on for some hundreds of years, by and large, our waters are sadly neglected and under-developed. It is an unfortunate fact, that a considerable proportion of our rivers, lochs and other waters are in the ownership of people who do not value them as they might, or who do not value them at all. Some of these waters are rarely, if ever, fished; many are let-off at nominal rents and fished to death, little, or nothing, being done in the way of safeguarding or replenishing the stock; while others are fish-less or over-run with coarse fish.

In Britain we are still in the process of spending our fishing capital in the form of trout-flesh. Close to large centres of population, trout have, either been exterminated, or been preserved only by care and enterprise, these trout being available only to members of expensive clubs or to private owners who have valued their trout-fishing sufficiently to keeper it adequately and fish it within reasonable limits.

The great mass of anglers—and most of them come from the towns—are forced to fan-out in ever-widening circles, trout becoming scarcer with every passing year. The time will undoubtedly come—and in my opinion it is well on the way—when native trout stocks will have been pared to the bone and the wandering angler, in search of cheap trout-fishing, will have nowhere left to go. When that stage has been reached, the angler may realize, as Lord Grey of Falloden wrote long ago: 'We cannot take all and give nothing.' Native stocks of trout cannot hope successfully to survive all the natural dangers of existence with the sport of angling thrown-in as an extremely effective additional hazard.

The only possible remedies for this unfortunate situation, assuming that fishing on the same scale is to continue, may be summed-up as follows:

(i). Artificial improvement of the environment, so that more food can be produced and a larger number of trout accommodated.

(ii). Elimination of obstructions, pollution, predators, and other causes inhibiting survival and natural

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reproduction and which limit the number of trout reaching takeable size.

(iii). A general realization that artificial addition to the stock is absolutely essential ; also that fishing must inevitably cost more in order to provide money for the purchase of artificially-reared trout.

(iv). Bringing into use the countless ponds, lakes, reservoirs and other waters, at present devoid of trout, but which, with proper treatment, could often be made into excellent trout waters.

(v). The construction of more artificial waters.

Artificial Waters. A demand for trout for stocking has been created, not only by the long list of adversities listed in former pages, but also by the construction of new waters. Many reservoirs, artificial lakes, ponds, gravel-pits and, even, artificial streams, have been stocked with trout and are now giving excellent sport, augmenting considerably the fishing available in natural waters. One of the solutions to the intense demand for fishing is, undoubtedly, as suggested above, in the creation of more artificial waters. At the same time, it is encouraging to know that available evidence shows that, in such waters, the effectiveness of stocking is often greater and the cost decidedly less than in rivers and lakes that are as old as the hills and fields that overlook them.

CHAPTER 2

On Water

TROUT, like every other organism, must have a suitable environment if they are to thrive.

The following notes provide, without undue waste of words, a guide to the basic needs of trout. A trout is really 'pretty tough'. But in common with every other creature, it has been designed to function in obedience to a particular set of laws, the disruption of which is, inevitably, harmful, or possibly fatal.

Water is the element in which trout live. That water must be up to a minimum physical and chemical standard if trout are to live, let alone to grow fat and large.

PHYSICAL FACTORS

Rate of Flow. The current, or speed, of water can vary from five or six feet per second in rapids, down to almost stagnant conditions. Under these varying conditions, the type of bottom will also vary, from rocks or slab formations, to gravel of gradually diminishing size and, finally, to silt and mud. Current affects the well-being of trout in a number of ways. In fast water a trout uses up more energy in maintaining its position than in slow or static water. Vegetation, in very fast water, is either absent, or less prolific than in slow. Rapid waters usually have far less food than sluggish ones. Fast water is likely to be more uniform in temperature than static water. In general, the fastest waters hold the smallest trout and the biggest trout are usually to be found in slow waters, or, at any rate, in waters where there is a high proportion of slow to fast water. Slow water, in spite of its greater productivity potential is, nevertheless, not always desirable. Slow water deposits mud and is, frequently, liable to choking with heavy growths of weed and algae. The more productive trout waters (e.g. R. Kennet, Test, Itchen and others) have speeds ranging from about 2 feet per second down to 0.25 feet per second. Apart from mill pounds, the flow of which ranges from 0.5 to 0.1 feet per second, such waters will be fairly free from mud, but, at the same time, good producers of natural food and provide ideal conditions for dry-fly fishing.

Current also affects the power of trout to reproduce themselves. Trout usually choose water with a rate of roughly 2 feet per second for this purpose, probably because the size of the bottom materials is suitable for redd-making at about that speed, while, at the same time, the current aids the makings of redds and affects both the fertilization of the ova laid in them and their subsequent development.

Density of water. Water is most dense at a temperature of just over 39 degrees F. (4 degrees C.). Water colder than this floats on the surface and, in frosty weather, it may cool down to 32 degrees F. and form a layer of ice. Above a temperature of 39 degrees F., the warmer the water, the less dense it is. This has a considerable effect on ponds and lakes of any appreciable depth and means that during the summer the warmer water will be at the surface and the colder water below. The shallower the water, the more uniform will be the temperature. Deep waters will have a layer of warm water during the summer, extending downwards for twenty or thirty feet to what is known as the thermocline, below which level, the temperature will fall rapidly for some distance and gradually ease-off until, at the bottom of the lake, the lowest temperature is reached. During the summer the less dense, warmer waters, carry the largest quantity of life and the denser, colder waters tend towards sterility.

Formation of Ice. Ice forms most readily in shallow water. A pond covered with ice is insulated from the air. The water in it may be liable to consume all the available supply of oxygen. While metabolism is greatly slowed down in cold water, losses of trout have been known to occur in closed ponds and lakes which have remained frozen for some considerable time.

Type of Country. The character of the country, from which a particular water is derived and over which it flows, will have a large bearing on the composition of that water. It may, as a result, be peaty, chalky, acid, alkaline, or possess other characteristics having a bearing on the welfare of any trout in it. Flat, fertile country will, for example, tend to have rivers and lakes of higher potential productivity than hilly, barren regions. Waters in southern England, for this reason, produce more pounds of trout for a given area or length than waters of the more sterile regions of Wales or Scotland, though a number of other factors are also involved.

Altitude. The higher a water is above sea-level, the less likely is it to be a heavy producer of trout. If a stream, it is likely to be turbulent and provide unfavourable conditions for aquatic life, though small trout may often be present. If a lake, it will usually be relatively sterile. In both cases, temperatures will be lower as altitude increases. Low temperatures inhibit the growth of trout and the food of trout alike.

Latitude. Leaving other considerations on one side, the further north one goes, the lower the productivity of a trout water will tend to be. This is largely due to a lower temperature and less sunshine.

The Seasons. During the winter, activity in water is very much retarded. Growth and reproduction of plant and animal life is virtually at a standstill. A great burst of energy comes when the water warms in spring and the peak of activity is reached by July or August, after which, it gradually diminishes.

Strangely enough, trout (and salmon) are the only aquatic creatures choosing the winter for breeding purposes, say, from November to January, though spawning activity is at its greatest when there is a slight rise in temperature during a mild spell.

Light. All plant life is dependent upon a varying amount of light for growth and its ability to maintain itself. The penetration of light into water therefore has an important, if indirect, bearing upon productivity in terms of food and, finally, upon the number and size of trout it is able to support. Light is absorbed, in penetrating water, to an amount equivalent to the square of the depth. Light is also reflected and refracted on striking water. Penetration is affected by the turbidity and colour of water and light can penetrate most deeply into very clear water. The shallowest areas of ponds, lakes and, to a lesser extent, rivers, are the most productive, owing to the fact that a greater intensity of light reaches them. Very deep waters tend to sterility, as light is unable to reach the bottom and rooted vegetation cannot become established.

Depth. In streams and rivers, the deeper portions are usually the most productive portions, mainly due to the slacker current, which enables higher forms of aquatic life to maintain position more readily.

In ponds and lakes, the factor for depth is of major importance. The shallower portions produce the bulk of the food-supply, relatively little food being produced in deep water, owing to the fact that the penetration of light is limited. Water up to 4 feet in depth is the most productive, little rooted vegetation being produced below a depth of 10 to 12 feet, except in the clearest water.

One of the reasons why artificial reservoirs seldom produce a heavy weight of trout per acre is because of the usually high proportion of deep water to shallow. Many Highland lochs are also very deep and, although a lot of trout come out of them during a year, in terms of pounds of trout per acre the yields are low.

Shallow water has, however, serious disadvantages, the chief of which is that, pond and lakes, lacking depth, tend to overheat during the summer and are liable to freeze-up during frosty weather.

Deep water is usually less well oxygenated than shallow.

Type of Bottom. We have already noticed that the speed of water has a large influence on the size of the bottom particles, which will vary from rocks, in rapids, to mud, in sluggish reaches. In general, lake and river bottoms with the smaller particles will be the most stable and will be the highest producers of plant and animal life. The character of the bottom materials, the pace of the water and the fauna and flora that will colonize such areas, are all intimately related.

Electrical Conductivity. The electrical conductivity of a water depends almost exclusively, upon the substances dissolved in it. The conductivity of a water being proportional to the amount of its dissolved matter, it follows that any change in the character of the water will be indicated by a change in conductivity. This may, occasionally, be a useful means of ascertaining whether any pollution is taking place, since the conductivity of water may rapidly and easily be determined, though the apparatus is rather elaborate and expensive. Waterworks often have automatic conductivity-meters installed at their reservoirs so that a continuous record of conductivity is obtained, any sudden change being additionally indicated by an alarm-bell system.

From the practical fishing point-of-view, it may be stated as quite definite that the lower the conductivity of a water the less productive will it be, pure waters being less productive than those that are richer in dissolved substances.

The unit of conductivity usually adopted is the reciprocal of the megohm. As temperature influences the readings, a correction to 20 degrees C. is made so as to preserve uniformity.

Distilled water should theoretically, have a conductivity of zero. In practice, it is never possible to obtain a perfect sample. Two batches of distilled water, made for topping up accumulators by a distillation-plant working off water used for a large trout hatchery, had conductivities of 5.8 and 8.6. The hatchery water itself has a conductivity of 425, which illustrates, admirably, the difference between a water devoid of dissolved minerals and one containing a considerable amount.

Most of the chalk-streams have conductivities ranging from 400—450 (R. Dunn 425; R. Kennet 430; Shalbourne 410; R. Itchen 440). Rain-fed streams have lower conductivities and produce smaller fish (R. Arrow 340; R. Teign 130; R. Bovey 97.5). Many Highland lochs have low conductivities (Loch Garry 41; Loch Achilty 67.5; Loch Lundie 45) and the trout in them are small. In general, waters with conductivities of less than 100 are poor producers of trout of any size, though many are often excellent breeding waters.

Pressure. Water is almost incompressible. Pressure undoubtedly plays a part, however, in the activity of aquatic creatures and they are susceptible to rapid changes of barometric pressure.

Pressure also varies with the depth. At one foot deep the pressure is 0.433 pounds per square-inch. For all practical purposes pressure increases by about half-a-pound p.s.i. for every foot of depth. Trout may occasionally go quite deep in search of cool water during hot weather. Normally, however, they appear to be adapted to function at pressures varying from 0.5 to 7.5 p.s.i.

Floods. Waters liable to heavy spates—such as our Devonshire or Welsh rivers and those in the Scottish Highlands—are not usually producers of large, or even medium-sized trout. Conditions for plant and animal life are too unstable. On the other hand, floods are sometimes beneficial in clearing-away heavy deposits of mud, evidence of which is provided by the improvement in the beds of some of our south-country rivers after a thoroughly wet winter. Floods may cause damage of one kind or another to weirs, bridges and similar structures and cause changes in the conformation of beds of gravel. But it is doubtful whether they have any harmful effect on trout of a year or more's growth, apart from causing movements of fish from one section of a river to another. Fry of trout and ova are liable to damage by floods. Young fry are sometimes choked by silt clogging their gills. Ova in the redds may be damaged by movement during the 'tender' stage, or the redds may be filled with silt and the ova suffocated.

Drought. Shortage of water, caused by lack of rainfall, can affect trout in a number of ways. In the autumn, spawning may be delayed until the rate of flow is sufficient to tempt trout on to their traditional spawning shallows and may prevent them from running-up feeder-streams, or jumping obstacles. A drought in winter can be serious on the upper reaches of rain-fed streams ; by then, trout will have spawned and many of the redds may, as a result of the drop in the water-level, be exposed to the air, where a frost would immediately kill them off. Summer droughts are also unfavourable, as the water becomes vitiated and the trout dour, sluggish and shy. Any form of pollution will be aggravated during a period of drought, since dilution will be less. Droughts also encourage the growth of excess amounts of algae and rooted plants. There is a danger of the water overheating during summer drought. Drought brings the added risk of de-oxygenated water and, at the same time, increases the possibility of heavy concentrations of carbonic-acid gas and other products of decomposition.

Surface Tension. The surface tension of water has little, if any, direct effect on trout. Indirectly, however, it has a very great bearing on the sport of fly-fishing, since, without it, trout would be unable to rise to flies on the surface and all their feeding would be done beneath the water. Dry-fly fishing would, for the same reason, be impossible, since no fly would float.

Solar Energy. Trout feed on insects, crustaceans, molluscs and other aquatic creatures too numerous to mention here. These creatures either feed on creatures smaller than themselves or on plant life. Ultimately, all creatures are entirely dependent on the ability of chlorophyll-containing plant life to use the sun's energy to manufacture sugars and starches from carbon dioxide and water. Fish and all other animals are unable to utilize the sun's energy in this way. As already noted, the penetration of light (i.e., energy from the sun) into water, plays an essential part in the productivity of water. Waters in parts of the country where the number of hours of sunshine are greatest, are, if one disregards other factors, likely to be the most productive. The effect of trees, providing shade, can inhibit the growth of plant life and, in consequence, the animal life dependent upon it. Thus, ponds and lakes in woods, and stretches of stream and river heavily bushed, or overhung with trees, are seldom highly productive. Very deep water, since the penetration of sunlight is negligible, is, for the same reason, relatively sterile.

Supply of Water. The quantity and quality of the water in any stream or other body of water is, needless to say, of paramount importance. Trout will not thrive, and may not even live, in water falling below a certain volume and quality. This question, being inter-related with all the other problems, need not be followed any further at the moment.

Temperature. Temperature is, undoubtedly, one of the most critical factors affecting trout. Trout are relatively inactive and grow very slowly at low temperatures. The most favourable temperature-range for growth is probably between 55—65 degrees F. Waters with low temperatures will, in general, be capable of producing small trout, or trout that are very slow growing. Digestion and overall metabolic activity is more rapid at high temperatures than at low. At a temperature of 35 degrees F., trout show very little eagerness for food and any food they take will take some days to digest. Trout feed well at temperatures from 45—65 degrees F., the rate of digestion at 65 degrees F. being about twice as rapid as that at 45 degrees F. The waters of southern England, which have mean annual temperatures appreciably higher than those in the north and other cold areas, tend, for this reason, to produce larger and more rapidly-growing trout. As already observed, latitude plays an important part in the growth of trout, owing to its effect on temperature.

Trout are highly susceptible to high temperatures, or to sudden changes of temperature. If a trout is plunged suddenly from one water into another, where the difference between the two waters varies by more than about 5 degrees F. the effect will sometimes prove fatal. This point is of some importance during trout-stocking operations, care being taken to see that any temperature-changes are gradually made. The body of a trout assumes the temperature of the water in which it is living. Any sudden change of temperature, therefore, affects the skin and outer layers of flesh more rapidly than the inner, producing chill or shock.

The danger-point for trout, as regards temperature, is approached at about 65 degrees F. Death can occur (excluding other factors) at around 70 degrees F. Experimentally, I have found that trout will survive short periods in well-oxygenated water up to 80 degrees F., but the thermal death-point, even in water supersaturated with oxygen, occurs very rapidly at about 83 degrees F. Any water liable to heat to 70 degrees F. throughout a substantial part of its area or depth, is a dangerous water for trout. Some workers have found that the rainbow trout can withstand slightly higher temperatures than brown trout; even so, I think that any temperature in excess of 65 degrees F. is getting close to the danger-point for rainbows as well as browns.

One of the reasons why high temperatures are dangerous is because oxygen cannot be held in solution to so great an extent as in cold water. Trout can only obtain their oxygen from the water and, therefore, as the water warms up, the rate of respiration has to increase. There is a mechanical limit to their ability to increase respiration above a certain point. This important question of oxygen supply is dealt with in a later paragraph, but it is important to remember here, that temperature and oxygen in water are intimately related and have an enormous effect on the welfare and survival of trout.

An interesting, final point about temperature, is its effect on the development of trout ova. The colder the temperature, the slower the rate of development. At temperatures just above freezing-point, development is negligible. Freezing causes the death of the ova. The ideal temperature for hatching trout ova is probably around 40 degrees F., at a mean temperature of which they hatch in approximately 100 days. At 50 degrees F. they hatch in 50 days. A reasonably low temperature is desirable for the incubation of trout ova, the vitality of the alevins being impaired at high temperatures. In South Africa, Dr. Hey, Director of Inland Fisheries, records a hatching time of 34 days for rainbow trout, at a temperature of 54 degrees F. and 21 days when the temperature rose to 61 degrees F. It is doubtful whether any temperature above 55 degrees F. can be regarded as safe or satisfactory for hatching trout ova and 50 degrees F. (at which temperature most of my own work has been done) is plenty high enough.

Wind and Wave Action. Wind plays an important part in mixing lake and pond waters. In this way, differing temperatures in different areas tend to be evened out. Wind also helps to oxygenate a water. Wind, by forming waves, causes erosion to banks and shore-lines. A shore that is much exposed to wave-action is likely to be unproductive, conditions being too unstable for many animals to become established.

Colour and Turbidity. Waters of a turbid character, that is carrying particles of matter in suspension, are rarely the best trout waters. The particles may be harmless in themselves, though often they are likely to absorb oxygen from the water ; but a major effect is to reduce the penetration of light and, by so doing, to impair the productive capacity of the water. Many waters are, to a greater or lesser extent, perpetually turbid. Excluding other factors, waters of reasonable clarity are likely to be the best for the production of trout and for fishing.

Odour. Many waters have a very slight smell, e.g., fishy, earthy, peaty, sweetish, fœtid. A water having an unpleasant smell is unlikely to be satisfactory as a trout water and any such odours should always be regarded with suspicion.

Variation in height of Water. Streams and rivers rise and fall, some slowly, some rapidly. Those that are subject to sudden and rapid changes in height are invariably the least productive. The gradual lowering in level of reservoirs or lakes during the summer months, reduces both the depth and the acreage and may have an appreciable effect on production. Areas of shore, subject to intermittent flooding and drying, by changes in level, are bound to provide unstable conditions for both plant and animal life. Sudden lowering of water levels, frequently causes the immediate loss of many creatures living in the mud or silt, or adhering to plants or stones. Reasonably uniform levels for all ponds, lakes and reservoirs are, in every way, desirable from the fisherman's point-of-view.

CHEMICAL FACTORS

Waters vary enormously in their chemical composition, according to their locality, and may contain innumerable saline and gaseous constituents.

Rain, falling on the earth, particularly in the more remote districts, is of a high degree of purity, containing little in solution but gases derived from the atmosphere. Thereafter, according to the formation, character and human development of the land upon which it falls, it gradually dissolves soluble substances from the earth. The quality of a trout water is very much dependent upon the matter it contains; indeed, the very existence of trout in a particular water is largely determined by a number of chemical factors, some of which are fairly flexible, others permitting very little in the way of compromise.

The following notes deal briefly with the more important of these factors.

Oxygen dissolved in water. Trout do not obtain their supply of oxygen directly from the atmosphere, as do human beings, land animals and birds. Trout are equipped with gills and oxygen passes into the blood-stream via the thin membranes covering the gill-filaments. It is thus obvious that, without a readily obtainable supply of dissolved oxygen, respiration will either be laboured, impairing the health, appetite and general activity of the fish, or the respiratory mechanism will be incapable of extracting the necessary amount of oxygen from the water and the fish will quickly die.

The amount of oxygen that water can hold in solution varies with the temperature. For example, water at 5 degrees C. (41 degrees F.) can hold nearly 50 per cent. more dissolved oxygen than water at 20 degrees C. (68 degrees F.). This means that the warmer the water, the more difficult will it be for trout to obtain the desired amount of oxygen. A fully saturated water at 41 degrees F. contains 1.23 parts of oxygen per 100,000, whereas at 68 degrees F. it would be fully saturated at 0.89 parts per 100,000.

Trout thrive best in water that is fully saturated and will die if the saturation falls much below 0.6 parts per 100,000, particularly if the temperature is high.

The table given below gives the oxygen saturation at various temperatures :

Degrees Centigrade	*Degrees Fahrenheit*	*Oxygen Saturation in parts per 100,000*
5	41.0	1.23
6	42.8	1.21
7	44.6	1.18
8	46.4	1.16
9	48.0	1.13
10	50.0	1.10
11	51.8	1.08
12	53.6	1.06
13	55.4	1.03
14	57.2	1.01
15	59.0	0.98
16	60.8	0.96
17	62.6	0.95
18	64.4	0.93
19	66.2	0.91
20	68.0	0.89

Oxygen deficiency. This may be caused in several ways, the chief of which are described below :

(a) Deficiency caused by fish and other inhabitants. Everyone has seen goldfish in a bowl gasping at the surface, or, possibly, floating belly upwards. This is caused

by overcrowding, the consumption of oxygen by the fish in the bowl gradually lowering the saturation to a dangerous, or lethal level. In nature, such a state of affairs occurs but rarely. It is seldom that waters are so heavily stocked with fish or other creatures that oxygen is consumed faster than it is replaced. The most likely environments for this to happen are ponds or lakes, small in area in relation to their depth. In such cases, vegetation may be slight, or lacking, the only means of replacing oxygen being via the surface, which is a very slow process. Heavily stocked waters of this type may be liable to loss of fish through de-oxygenation. In practice, such waters are unsatisfactory for fish, being poor producers of food; hence they should not be heavily stocked.

(b) Consumption of oxygen by algae and growing plants during the hours of darkness. During the daytime, green plants give out oxygen and consume carbon dioxide (photosynthesis). At night this process is reversed. Sluggish reaches of river, ponds and lakes, carrying heavy growths of weed or algae, may, sometimes, become deficient in oxygen during the night, this being particularly significant when the concentration of oxygen is already low, due to high temperatures. Many cases of trout, believed to have been killed by this means, have, from time to time, been recorded.

(c) Effect of rotting vegetation. As vegetation at the bottom of a pond or lake decomposes, it consumes oxygen during the process. The rate of decomposition is retarded during cold weather and accelerated during hot spells. Stagnant waters, carrying a large amount of rotting vegetation, are, for this reason, not usually suitable for trout.

(d) Decomposing sewage or other organic matter. Sewage and other organic matter, entering a river, is acted upon and broken-down by bacteria into simple inorganic substances. Oxygen is consumed during this process. If,

therefore, there is much of this organic matter, the process of oxidation may cause a very heavy deficiency of oxygen, causing the death of trout.

(e) Effect of storms. Waters liable to heavy flushes of flood-water during cloudbursts and thunderstorms may, occasionally, have so much organic matter brought in from the surrounding land (or from semi-decomposed mudbanks) that the oxygen becomes depleted and fish are killed. Fish are sometimes killed by muddy water, perhaps through a lake being drained, or, due to dredging, or other work higher up. Probably muddy conditions do not worry the fish unduly, the real cause of the damage being due to the oxidation of the finely divided particles of matter and the resultant lowering, to a dangerous level, of the oxygen content of the water.

(f) Natural deficiency. Occasionally waters are naturally deficient in oxygen. This is particularly noticeable in water from bore-holes, sometimes used for hatchery work. Bore-hole water is sometimes less than 50 per cent. saturated with oxygen and, for that reason, may be unsatisfactory for hatching ova or raising fry. The headwaters of spring-fed streams are, also, likely to be deficient in oxygen ; yet, a few hundred yards further down, after flowing over shallows or weed-beds, they may be fully oxygenated.

Carbon dioxide. Carbon dioxide is given off during respiration by fishes and all other inhabitants of water. Green plants, in the absence of light, take in oxygen and give off carbon dioxide. Plants absorb carbon dioxide and give off oxygen when sufficiently illuminated. Carbon dioxide is also produced from organic matter by bacteria as one of the by-products of decomposition. In alkaline waters, much of the carbon dioxide combines with carbonates to form bicarbonates. A high concentration of carbonic-acid gas lowers the alkalinity of a water, and is the chief reason for acid waters being acid. Heavy concentrations of carbon dioxide are lethal to trout. Often the cause of death is a combination of high acidity, caused by excess carbon dioxide, and a shortage of oxygen. The best trout waters do not usually contain more than a very small amount of free carbon dioxide : say up to 1 part per 100,000. Large amounts of carbon dioxide in a water would be an indication of its unsuitability for trout.

Alkalinity and Acidity : pH. In spite of what some authorities say, the pH of a water is a very useful guide to what may be expected in the way of productivity. A water is neutral at about pH 7.0. Below pH 7, hydrogenions are in excess and the water is acid ; above pH 7, hydroxylions are more plentiful and the water is alkaline. pH may readily be measured with the aid of indicators and sets of standard tubes ; or by comparators, fitted with standard colour discs for matching with the sample. More elaborate electrical apparatus is also used, but the simple indicator technique serves every practical purpose. My own preference is for the Lovibond Comparator fitted with discs for Bromo-thymol blue (pH range 6.0 to 7.6) and Cresol red (pH range 7.2 to 8.8). During the 20 years I have had this simple apparatus I have recorded some hundreds of pH readings from all over the country. I have no hesitation in stating that a water with a low pH is likely to be low in productivity. I am less confident about a high pH being an infallible sign of high productivity, though often this is so. It is, of course, necessary to consider the pH value in conjunction with a number of other factors, both physical and chemical ; also to remember that there may be a seasonal or diurnal variation.

Hard and soft waters. Soft waters are often, though not always, acid. Hard waters are usually alkaline. Hard waters are normally much more productive than soft waters. Hardness is caused by the solution of various salts, chiefly those of calcium and magnesium. The chief reason, for the greater productivity of hard waters compared with soft, is that plant life is dependent upon these inorganic salts, any deficiency being reflected in the quantity of the animal population, directly, or indirectly, dependent upon the amount of vegetation. Many creatures, such as snails, crustaceans and zoo-plankton, require varying amounts of calcium and other salts and are unable to tolerate conditions of undue softness. Waters of less than 10 degrees of hardness are very sterile. Waters from 10—15 degrees of hardness are unlikely to be very productive. The most productive trout waters usually range from 20—35 degrees of hardness.

Fertility. Sterile water will not grow fish or fish food. The fertility of a water is the chief factor determining the number and size of trout it can support. Phyto-plankton obtains its nourishment from the inorganic constituents of water, these including salts of nitrogen, phosphorus, potassium and calcium. Bacteria break down organic substances into inorganic substances of this kind, which can directly be used by plants in the presence of sunlight. The smallest animals (zoo-plankton) feed on the phyto-plankton (the smallest micro-plants) and are themselves consumed by larger animals or fish. In this way, food is made available to trout, trout feeding on a very large number of creatures, the variety of which will vary with the particular habitat. All these creatures are dependent, in the first instance, on the amount of fertility in the water.

Pollution. The environment in which a trout lives is very sensitive to interference by man. Any kind of matter, finding its way into water, is bound to have some effect, the magnitude of which will depend on the nature of the substance, whether it is soluble or insoluble, and its quantity in relation to the volume or flow of the water into which it is released.

Sewage, consisting chiefly of organic matter, is attacked by bacteria and releases inorganic substances, usable by plants, as already mentioned in the previous section. Oxygen is consumed in the process and, if the volume of sewage is large in relation to the volume of water, more oxygen may be consumed than can be tolerated by the fish and other animals living in the water. In heavy concentrations of sewage, all the oxygen may be used up in its immediate vicinity, resulting in the formation by anaerobic bacteria of poisonous substances like ammonia and sulphuretted hydrogen.

Apart from sewage, there are the trade wastes, most of which have a chemical effect of an adverse nature. Gasworks, mines, iron works, chemical factories, dye works, jam factories, milk-processing plants, paper mills, tanneries, textile manufacturers, etc., all give effluents of a deleterious nature. In fact it is probably true to say that no form of trade waste is likely to be beneficial. Some of these effluents reduce the oxygen content of the water; a large number are directly poisonous ; while others may have a mechanical action such as obstructing gill-filaments, raising the turbidity, or throwing down silt.

CHAPTER 3

On Trout

Adequate Food. Food in large quantities is not absolutely essential to the welfare of trout. Trout are sometimes hardy and numerous in waters where food is scarce. For example, many streams in the West Country, Wales and Scotland, are excellent breeding streams, containing large numbers of wild trout. These trout are game and hardy, but seldom grow big, the reason being that there is insufficient food to enable them to do so

Waters holding large, or fair-sized trout, in appreciable numbers, are invariably well provided with natural food. Fast waters tend to produce less food than slow ones. Alkaline waters usually produce more food than those of an acid nature.

Anything that human beings can do to increase the natural food supply in particular waters, will, almost certainly, result in those waters producing a larger weight of trout per unit of length or area.

Digestion of Food. A trout's digestion varies with the temperature of the water. This is a fortunate provision of nature, cold waters being less well provided with food than warm ones. The colder the water, the less the appetite and any food consumed is longer in being assimilated. it therefore follows that in cold water a trout will get less to eat, but that it will be satisfied with less. Digestion is about twice as rapid at 65 degrees F. as at 45 degrees F. Above 65 degrees F. trout tend to become sluggish and disinclined to feed, particularly if the water is not well-oxygenated. Below a temperature of 45 degrees F., appetite becomes progressively less, while at 35 degrees F.

the inclination to feed is almost entirely lacking. A rise in temperature of a few degrees, even when the water is cold, will tend to stimulate appetite. The rate of digestion is, however, always directly controlled by temperature, increasing in rate with a rising temperature and decreasing as temperatures fall.

Natural Foods of Trout. It is impossible, in a book of this length and scope, to give more than a cursory account of some of the more important living creatures preyed upon by trout. Hundreds of different kinds of animal, may, on occasion, be found in the stomachs of trout and all of them are of some value. The nature of the creatures finding their way into a trout's stomach will depend on several factors. Firstly, it will depend on the prevalence of particular kinds of food, trout tending, on the whole, to feed substantially on those creatures most readily obtainable with the minimum of effort. Secondly, it will depend on the character of the water, waters of certain characteristics tending to produce foods tolerant of those conditions. Thirdly, the individual preferences of particular trout must be considered, some trout showing a marked preference for one kind of food, even though other kinds are abundant.

Trout are predatory fish and consume very little, if anything, of a vegetable nature, except accidentally. Indirectly, however, they are entirely dependent upon an adequate supply of plant life, particularly of the lower forms, such as algae and phytoplankton, upon which the smallest living organisms feed. Small zoo-plankton are consumed, in turn, by larger zoo-plankton, these being eaten by insects, insect larvae, worms, beetles and small fish. Until food has reached a size somewhat larger than a pin's head, it is of little value to trout, other than very young trout fry. As a trout grows, it graduates to food of larger dimensions, though at times even very big trout will feed, somewhat in the manner of whales, on food approaching microscopic proportions, provided it is sufficiently plentiful. Trout in different waters will usually be found to subsist on certain staple foods ; even in the same water (such as a fair-sized lake) trout in different parts of the lake will tend to feed on different foods, usually for the reason that slightly altered environment (influenced by factors such as depth, current, type of bottom, etc.) will favour the production of species particularly adapted to the local conditions.

Composition of Foodstuffs. The natural food of trout is about 50 per cent. protein and they are incapable of existing on a diet low in protein. Their capacity for digesting fats and carbohydrates is also limited. Hence the expense of growing trout artificially, protein-rich food being by far the most costly.

Detection of Food. A trout, finding itself in a particular environment, is dependent upon its ability to detect food in order to live. This is achieved chiefly by its senses of smell and taste.

A trout has two possibilities of acquiring food open to it. Either it can cruise about searching for food ; or it can wait for food to come to it. In ponds and lakes, trout feed chiefly by the former method. They swim about near the bottom, picking molluses or other creatures from the vegetation growing on the bed of the pond. If weed-beds are extensive they may search these systematically, cropping on molluscs, insect larvae, small fish, crustaceans and anything else they happen to see and fancy. At times, there may be sufficient, surface-food in the form of midge, gnats, sedge-flies, or mayflies, to tempt them to cruise immediately below the surface, rising at anything coming within their range of vision. In streams—and any water where there is appreciable drift or current—there will be less tendency to range about. Trout will usually take up definite vantage-points, feeding on anything suitable drifting past at any level beneath the surface ; or, if there is a hatch of fly, lying nearer to the surface and watching intently for flies to float over them. There seems little doubt that vision plays the major part in the detection of all kinds of food, though trout will often tend to be selective in the matter of taste, size, texture, hardness, or colour of their prey. The general probability is, however, that they will take the food coming most readily within their range of vision, assuming that they find it palatable and that it can be caught with the minimum expenditure of energy.

Feeding Habits. The feeding habits of trout are, of course, largely bound up with the previous paragraph. Their habits vary with the type of water and the quantity and quality of the food available. Trout from the same water, on the same day, will often be found to contain different types of food in their stomachs, even if caught within a few yards of one another, or even from the same pool.

Effect of Quantity of Food on Growth. Big trout are often found in waters considered to be deficient in food. Such waters are usually lakes of considerable area and these big trout—exclusively cannibals—are few and far between. Waters producing trout of good average size are invariably well provided with natural foods and the weight of trout that a water is capable of producing is directly proportional to the food-supply. Unfortunately, it does not always follow that, because a water is well provided with food, it can produce either a large weight of trout or trout of large average size ; but to expect trout of consistently satisfactory weight from barren waters is to expect the impossible. It is therefore clear that any means of improving the food-supply of a water is likely to be followed by an improvement in the average size of the trout it contains.

When do Trout feed most ? The bulk of a trout's feeding is done in the spring and summer, for the simple reason that it is during that period that food organisms are most numerous. This is very convenient for the trout, because rising temperatures in spring induce a greater appetite, just at the very moment when there should be something in the larder to appease it. In the south of England, Brown Trout feed voraciously right through October, until the onset of the spawning-season early in November. This applies more particularly to the hens. Trout may feed at any time of day and for many different reasons. Round about noon and just before sunset are, perhaps, the chief times of feeding, though a certain amount of feeding is likely to continue throughout the day and night. Surface feeding to flies is, of course, dependent upon the time of hatches of the particular species coming up. Two factors may possibly have more influence on trout commencing to feed than others. These are a rise in temperature (providing the rise is not too much) and a rise in the oxygen-saturation-level of the water. A rising temperature increases the general metabolic rate, while more oxygen supplies the fish with greater energy and, apparently, gives it a psychological boost into the bargain.

Food requirements of Trout at different ages. A newly-hatched trout takes no food from outside sources for a matter of anything from 3 to 6 weeks, according to temperature. At a temperature averaging 50 degrees F., Brown Trout come on to the feed in approximately 28 days, Rainbow Trout in about 21 days. During this pre-feeding period they live on the contents of their yolk-sacs, the contents of which are gradually absorbed, the sac becoming atrophied by the time the little trout have acquired their final shape and are ready to feed.

At first they move about very little—an inch or two either way—and snap at anything, edible or otherwise, passing within reach. At this stage, they are dependent upon the smallest organisms being carried to them by a current of water; they cannot go forth and seek food. Usually they lie close to the bottom alongside a stone, working very hard to maintain their positions. Unless food reaches them, they will gradually weaken and be unable to stem the current, drifting away downstream until picked up by some larger trout, or other predator, or dying of starvation. During the first week or two, they feed chiefly on zoo-plankton and other very small creatures. It is an unfortunate fact that at the very time when newly-hatched trout are coming on the feed, food is often scarce, particularly if a cold spell sets in at the time when they are ready to commence feeding. If they survive the initial stage of learning to feed and finding enough to keep them going, they are, subsequently, better able to fend for themselves. No longer are they entirely at the mercy of the current ; they can move about more easily and hunt for food, instead of waiting for food to come to them. By mid-summer, the survivors are able to obtain food easily. Their chief danger at that stage is not starvation, but capture by other trout, eels, kingfishers and all the many other creatures liable to attack them.

By the time it is a year old, a trout can feed on a larger class of prey. It can consume shrimps up to adult size, the smaller molluscs and the young of all species of mollusc. Most kinds of fly and their larvae are also well within its capacity. It may even consume the fry of minnows or coarse fish.

By the time it is two years old, a trout can take anything for which nature intended it.

The bulk of food consumed by trout keeps pace with its growth. By the time it has doubled its weight, it will, on average, be taking double the amount of food. An average yearling of 5-inches in length will, for example, weigh about 60 times as much as it did when it commenced to feed and will require 60 times as much food every day to keep it going. In another year's time, it may be 10-inches long and weigh about 660 times as much as it did when feeding commenced two years previously. It is thus readily apparent how growth is so dependent upon the available supply of food. Trout-flesh cannot be produced out of 'thin air.'

Starvation. Except when they are very young and weak and have had insufficient time to build up reserves of food in their muscles, trout seldom die of starvation. A fair-sized trout would be capable of living for months without any food at all, gradually becoming thinner and wasting away. In cold mountain streams, trout get very little to eat during the period from November to March. During the winter, condition is lost very much more slowly than would be the case if a comparable shortage of food existed during the summer. In waters such as moorland streams and hill tarns, trout are often living on the border-line of starvation ; but they readily adapt themselves to these austere conditions, combatting the food-shortage by refusing to grow.

Food Conversion. By no means all the food consumed by a trout produces growth. Much is absorbed to provide energy and in the function of all the internal organs ; a considerable percentage is lost in the form of excreta. A generally accepted figure is that 7 lbs. of animal food is required to produce 1 lb. of trout-flesh. This means that a trout of 2 lbs. has eaten about 14 lbs. of food during its life to that date, made up of tens of thousands of organisms of various kinds. For obvious reasons, the exact amount required is not precisely known.

More information is available in the case of artificial foods. In America, a great deal of research on this subject has been carried out, chiefly with a proportion of dried foods in the ration. For example, a mixture of 70 per cent. beef liver and 30 per cent. salmon-egg meal produced 1 lb. of trout for 2.06 lbs. of the mixture ; 60 per cent. sheep-liver and 40 per cent. fish-meal produced 1 lb. of trout for 2.97 lbs. of the mixture. Fresh foods contain a high percentage of water and therefore a larger bulk is required than when feeding mixtures containing dried foods.

During the past 25 years I have carried out numerous experiments of this nature myself. A long-term trial during 1935—36 produced the following results:

Diet	*Weight in lbs. to produce 1 lb. of Trout*
1/3 White Fish 2/3 Lean Meat	6.1
2/3 White Fish 1/3 Lean Meat	5.9
¼ White Fish ¼ Lean Meat ½ Meat Meal	3.8

A large-scale experiment during 1948—49, using about 75 per cent. fresh cod flaps and 25 per cent. fresh lean meat, gave a conversion-ratio of 3.8. Actually 12,000 lbs. of trout were produced by feeding in a total of 20 tons 13 cwt. of food. This is the largest experiment of which I have knowledge and the result was considerably more favourable than I had been led to expect, the reason for the high conversion-ratio possibly being connected with the rate of feeding. Under certain conditions—temperature of about 65 degrees F. and a water fully saturated with oxygen—a trout can consume up to 20 per cent. of its body-weight in a day. This is not an economical feeding-rate when using artificial foods and the optimum rate for water at a temperature of about 58 degrees F. is probably from 5—7½ per cent per day. During the winter a trout will not usually consume more than 2½ per cent. of its body-weight in a day; and in cold weather only 1 per cent. or none at all. This is the reason why trout grow fast at fairly high temperatures of 55—65 degrees F., assuming that sufficient food is available to enable them to make use of it.

Growth-Rate. We have already observed that a yearling trout may have increased its fry-weight by some 60 times. A 5-inch yearling, reaching 10-inches as a two-year-old, will increase its weight about 11 times during that period. Supposing it reaches 13-inches as a three-year-old, its increase in weight during the third year will only be about 2.1 times. It is thus obvious that as a trout grows, the rate of increase declines. On the other hand, the actual weight put on, up to a certain age, is considerably greater each year. Fry, at the commencement of feeding, weigh about 1,500 to the pound ; yearlings of 5-inches about 24 to the pound ; two-year-olds of 10-inches approximately 2¼ to the pound, while the 13-inch three-year-olds will weight about 15-ozs. each. The 13-inch fish actually weighs about 1,400 times as much as it did as a fry, commencing to feed, three years previously and will require 1,400 times as much food every day.

The pace of growth is seen, normally, to be greater while the fish is young and, within reason, it is probable that the faster it grows while it is young, the larger it will eventually get.

Conditions favourable to the highest growth-rate are a moderately high temperature of around 60 degrees F., an alkaline water of high fertility and a moderate depth of water, not too deep and not too shallow. Such conditions will be favourable for the maximum production of food and, in the presence of abundant food, trout are likely to grow the fastest.

It is unfortunate that relatively few waters in this country are favourable for maximum growth-production. They are either too deep, too shallow, too cold, too warm, too acid, or too swift. It is possible to construct artificial waters that are highly efficient producers of trout. Regrettably enough, a large proportion of the artificial waters in Britain, not having been constructed primarily for trout-fishing purposes, are anything but efficient in that respect.

Time required to reach maximum weight. The age of trout, at their maximum weight, varies with different waters, as does the maximum weight attained. In waters where the feeding is average, a lot of weight is put on during the fourth year and still more during the fifth. A trout can readily grow from 1 lb. to 2 lbs. during its fourth year and from 2 lbs. to 4 lbs. during its fifth year. Subsequently, growth is likely to be much much slower, though some trout will go on growing for ten or twelve years. An artificially-fed trout, killed in 1924, weighed 14¾ lbs. and was 10 years old. Some trout will live to a considerable age. The oldest I have heard of was reported in 1951, to have died at a Canadian hatchery at 28 years of age. Some years ago a trout was supposed to have lived in a well for 27 years. In mountain tarns and hill streams trout of five or six years old may easily be no bigger than a well-fed southern trout of 18-months. Many trout appear to cease growing, or to grow slightly in length at the expense of girth, at about their sixth year. Elderly trout are rarely in first-class condition and seem to commence going back after reaching their sixth year, though, naturally, there are exceptions. How often are trout caught, obviously of considerable age, which would have weighed anything up to 20 per cent. heavier if in first-class condition ?

Spawning-check. The production of ova and milt is obviously a decided check to growth. Trout will, mostly, mature at the age of three years, though a small proportion will mature at two years and a very few, nearly always males, at one year old. The ova take approximately 12 months to ripen in the fish, getting larger all the time. This is achieved at the expense of growth, in spite of the fact that the best growth is made during the period of highest reproductive vigour, namely during the fourth and fifth years of life. The biggest fish for their age are sometimes sterile, though only a small percentage of trout are liable to sterility. When one considers the volume of ova produced by a female trout, it is not surprising that spawning should act as a check to growth; indeed, it is odd to me why the check is not considerably greater than it is.

I have some figures in front of me, relating to 10 trout I spawned in 1948. These were fish ranging in size from about 2 to 4 lbs. The table below gives details of the ova they produced :

Number	*Number of fluid ounces of ova*	*Size of ova per fluid oz.*	*Approximate number of ova per fish*
1	25	131	3275
2	23	128	2944
3	20	136	2720
4	21	126	2646
5	13	156	2028
6	19	147	2793
7	12½	123	1537
8	17	139	2363
9	19	117	2223
10	23½	133	3125

As a fluid pint of trout ova weighs rather more than 13 ozs., the above figures give a good idea of what a large part of the female trout's weight is due to the presence of ova, when approaching the spawning-date, attaining, in the case of heavy yielders, about 20 per cent. of the body-weight.

This big loss of weight, due to spawning, has to be made good—and can only be made good by the consumption and conversion of an adequate amount of food—if the angler, lucky enough to catch a big trout, is not to be denied the added pleasure of catching a big trout in perfect condition.

Condition of Trout. The condition of trout depends upon the ability of the fish to obtain sufficient food to maintain its bulk in proportion to its length. A trout deprived of food will continue to grow in length at the expense of girth and condition.

A "Condition Calculator" was designed by Mr. E. M.

Corbett many years ago and is still in common use in many places. The formula is as follows :

$$\textit{Weight} = \frac{\textit{Length (inches) cubed x Condition-factor}}{100{,}000}$$

By this formula the condition of superlative trout may run up above 50. A trout in good average condition will have a C.F. of about 42 and a very badly-conditioned fish may run down as low as C.F. 30. Some rivers normally produce trout of better average condition than others. Much will also depend upon the time of year, condition tending to improve during the period from April to September.

A method of expressing condition I use myself is based on a knowledge of what a trout of a certain length should weigh. Possessing a curve, giving this information, and reading off the weight for a certain length, it is simple to express the condition of any trout as a decimal part or as a percentage, the significance of which is immediately apparent. For example, my standard curve gives the weight of an 11-inch trout as 9.68 ozs. If an 11-inch trout is weighed and it goes 10 ozs., the condition is 1.03 or 3 per cent. above normal. Owing to the difficulty in weighing single small trout really accurately this system is much more useful when dealing with large numbers of trout (as in a trout hatchery), as a very reliable estimate of their condition can be formed by weighing some hundreds or thousands of trout at once and dividing the weight by the number of fish.

Size and Maturity. Size has little, if any, bearing on the age at which a trout will mature. Age is the determining factor and, as already observed, a very few trout mature at one year old, more at two years and the vast majority at three years.

Size attainable. The British record for Brown Trout is 39½ lbs. caught in the R. Awe in 1866. One from the

Great Lake in Tasmania is said to have weighed 40 lbs. (Turing : *Trout Problems*). Few trout reach anything like those weights, regrettably enough. Most of the very big trout come from Scottish or Irish lochs, where, for the most part, the average size of the trout does not exceed ½ lb. These big fish are—like all trout, given the opportunity—highly successful cannibals. There are a number of waters in the South of England where the odd six-pounder is caught fairly regularly : say once every other year. Most anglers, whatever successes they may have had during their lifetimes, probably class a trout as 'big' when it exceeds 2 lbs. and something very special if over 4 lbs.

Activity and Growth. Some trout are, undoubtedly, more active than others. This is almost certainly an inherited characteristic and, other things being considered, active trout are likely to obtain more food than sluggish ones and are, as a result, almost certain to grow faster and larger.

Winter and Summer Growth. We have already noticed that growth depends chiefly on two things : firstly, the amount of food available and, secondly, the temperature of the water. It therefore follows that growth is much more rapid during the summer than at any time of year, though trout will feed well from April until the end of October. In spring-fed streams, trout will continue to feed, and to grow, right through the winter (apart from a cessation for some weeks during the spawning period), but, in cold rain-fed waters, growth virtually ceases for several months during the winter.

Why are trout large in some waters and small in others? The answer to this question has already been given in previous paragraphs ; it is a question constantly asked by anglers. Any water, consistently producing large trout, undoubtedly possesses a better food-supply than a water

—possibly not dissimilar in general appearance—consistently producing pigmies. The explanation may usually be related to certain fundamental factors, e.g., quality of the water; depth of water; mean annual temperature, etc.

Advantages of fast and slow-growing trout. Strains of trout vary considerably in their capacity for making growth. Trout of the same strain and even offspring from the same parents also possess varying growth-capacities. The probability is, that trout, commencing life as large ova, possess an initial advantage enabling them to keep ahead; but large ova do not, necessarily, come from fast-growing fish, old fish tending to produce bigger eggs than young ones. My own view is that the fundamental reason why some trout are faster growers than others is connected with the amount of vitality inherited from the parents. It is noticeable that some alevins are far more vital and energetic than others and it is the energetic ones that commence to feed soonest and get away to a good start.

In my view, there is little to be said for slow-growing fish. They are less efficient converters of food and are unlikely to make the most of even an outstandingly favourable environment. There are obvious advantages in a trout being able to attain a given weight in the shortest possible time and, furthermore, I believe it to be true that the energetic fast-growing type of fish will be capable of obtaining more food from a given density of food-supply, hence enabling a water to produce more pounds of trout-flesh per unit area than if it contains trout of a slow-growing strain.

Respiration. A trout, like all other creatures, requires oxygen in order to keep itself alive. As a trout is totally submerged in water, the only way in which oxygen can be obtained is by the extraction of dissolved oxygen from the water itself. This vital extracting process is performed by the gills, which consist of fine filaments attached to gill arches, the filaments containing a network of very thin-walled blood-vessels. Water, entering by way of the mouth, is automatically passed out through the gill-slits, oxygen being absorbed and carbon dioxide released in the process. The rate of respiration (the number of times the gill-slits are opened and closed in a given period) depends on two factors, namely the temperature of the water and the percentage oxygen-saturation of the water. A low temperature will lower the oxygen requirements of the trout and, at the same time, enable the water to hold more oxygen per unit volume. A high temperature increases the trout's oxygen requirements and decreases the amount of oxygen that can be held in solution. Accordingly, the rate at which the gills operate is automatically regulated by the nervous system of the fish, so that the necessary amount of oxygen is obtained under all conditions. Under extreme conditions—high temperatures and low oxygen content—the mechanism is unable to cope with the strain and the fish will die. The rate of respiration will, of course, also depend on what the trout is doing. If at rest, respiration will be much slower than if it is stemming a swift current, or if it is frightened. Respiration in small trout is usually more rapid than in large ones. The rate of respiration will usually range between 30—100 per minute.

Overcrowding. It is quite possible for the stock of trout in a particular water to become overcrowded in relation to the area of the water and the available amount of food. This usually occurs in streams with superlative breeding facilities, or in lochs connected with an excellent stream-system. Such places are usually fairly remote and insufficiently fished either by anglers or by predatory birds and animals. Owing to the favourable conditions for reproduction, the survival-rate of fry is higher and more trout reach maturity than is usually the case. The result of overcrowding is for the trout population to become stunted. The inadequate rations are made to go round only at the expense of a very tardy growth-rate in individual fish. In my experience, there are very few waters overcrowded with trout, except in some West Country streams, a few Welsh streams and lakes and in parts of the Scottish Highlands. Their number is decreasing every year, owing to the pressure of fishing continually spreading outwards to more distant places. In the Midlands and South Country, the angler is such a successful predator—far more efficient than any otter or heron—that the majority of waters, far from being overcrowded with trout, is in danger of being fished out.

Disease. In the case of wild trout and artificially-reared trout living at large, disease is a very minor problem at the present time. There are, it is true, one or two diseases occasionally causing mortality on a considerable scale and no one would care to predict that some new complaint might not one day give cause for concern.

Fungus, a white mould forming on the skin of the fish, is probably the commonest of all complaints, invariably being associated with some damage to the tissues, such as a wound in fighting or by abrasion. Fungus is also responsible for the loss of millions of ova every year, attacking dead eggs first and gradually spreading through the whole of a redd. Fungus is also liable to be caused by unsatisfactory water conditions.

There are a number of infectious diseases of trout, most of them being confined to hatcheries, where they can usually be kept under control. Well-run hatcheries should have little trouble from disease, since, by knowing something about the various diseases and taking certain precautions, trout should be kept free from them. Most trouble of this kind is undoubtedly caused by trying to produce too many fish in too small a space, or on too meagre a water-supply, crowded conditions providing just the right kind of environment for the rapid dissemination of the bacteria and protozoa usually responsible.

There is insufficient space in this book to discuss the problems of disease in trout hatcheries, nor is the subject particularly relevant, but a few brief notes on those likely to be met with in open waters may be permitted.

Trematode worms (flukes), tapeworms, roundworms and threadworms may all occur in wild trout. A particular kind of hookworm has, in recent years, caused blindness among trout, particularly rainbows, usually in ponds, lakes or reservoirs. A number of reservoirs have also had trouble with a tapeworm (Diphyllobothrium) which causes death of the trout at about four years old and tends to reduce the average size of trout available for fishing.

Furunculosis, or 'boil' disease, is of bacterial origin and has been responsible for the loss of many salmon and trout in this country, particularly during the first two decades of this century. In recent years, epidemics have, fortunately, been few, probably because stocks of fish have acquired a high degree of immunity to it.

Trout, particularly rainbows, put into ponds and lakes containing coarse fish, are often liable to become attacked by protozoan parasites, to which coarse fish are particularly vulnerable. It is usually wisest to clear out all coarse fish from a pond or lake before stocking it with trout.

Competitors. The competitors of trout are legion and they vary in quantity and variety according to the type of water concerned. A competitor may be defined as any creature consuming food, directly or indirectly, that could be utilized by trout. As far as I know, there are no mammals competing with trout for food, with the very limited exception of the water shrew and the brown rat. Bird competitors are numerous. Most kinds of wildfowl might be listed, including swans, moorhens, coots and dabchicks, the latter eating as much as a large trout. Most birds, particularly swallows, swifts, martins, wagtails, wrens, and flycatchers, compete with trout for surface food. Grayling are very successful at getting a large proportion of the available food-supply and are more prolific than trout into the bargain. Eels, roach, rudd, perch, dace, gudgeon and minnows all consume a fairly high percentage of molluscs, insects and crustaceans, though some of them also eat a certain amount of vegetable matter. In many streams and lakes, particularly in the Midlands and South Country, minnows, sticklebacks, bullheads and loach, consume considerable quantities of insects and crustaceans. The shortage of fly in many trout streams is undoubtedly partly due to the large numbers taken in larval form, particularly by bullheads and sticklebacks. Trout also compete with other trout and, where the breeding facilities are good, compete largely with one another, other competitors frequently being scarce in waters where trout breed very successfully. Food is often scarce in such waters, to add to the degree of family competition.

Enemies. Anything like a full list of the creatures that attack trout is impossible here, but the following may be mentioned :

Mammals. Otters attack trout of all sizes from about six inches upwards. Water-shrews will catch trout up to three or four inches in length and are very voracious feeders for their size ; fortunately they are not widely distributed.

Birds. Cormorants are a great scourge on many lochs and waters near the coast. Black-headed and black-backed gulls also fish for trout. Terns catch a lot of small trout. Herons are increasing in numbers and kill as many trout as the fishermen during a season, where fishing conditions favour them. I estimate that in 1950 at least 5,000 trout were caught and eaten by herons at the Trout Farm at Hungerford ; in 1951 the number was between 8—10,000. Admittedly they do far more damage under artificial conditions than in open waters. Kingfishers take a lot of small trout; as, also, do dabchicks. I have also frequently watched moorhens taking trout fry; indeed almost every kind of bird of omnivorous habits (such as wrens, robins, blackbirds, wagtails) will, if given a suitable opportunity, take young trout.

Fish. Pike, perch and eels are the chief offenders. Trout also eat one another, readily taking to cannibalism from an early age. Most fishes will eat trout ova and fry, almost anything larger than itself being a potential enemy of trout fry.

Insects. The Water Beetle (Dytiscus) is most voracious and will kill fry and small trout; so are Water Boatmen (Notonecta), Dragon-Fly Nymphs and Water Scorpions. Luckily none of these creatures are present in many trout waters, since they prefer rather sluggish, shallow water.

Leeches: Trout may quite often be attacked by leeches. A common one is *Goemetrica piscicola,* which, in some waters, can become a great nuisance. Fish attacked by considerable numbers of leeches become thin and emaciated. The weaker they become, the more likely are they to be attacked by more and more leeches. Leeches are largely confined to ponds and lakes.

Fish Louse: Argulus foliaceus, the fish louse, can also cause considerable damage among trout. It is often spread among trout by coarse fish, which are liable to heavy infestation. The fish louse thrives most in rather shallow, warm ponds and lakes.

From the above list, a very short and inadequate one, the reader with little knowledge of trout might get the impression that trout have so many enemies that it is a wonder that any of them survive. Fortunately none of these natural enemies frequently become so numerous as to have decisively disastrous results on stocks of trout. Wholesale extermination is almost invariably due to some human agency: pollution, abstraction of water and the general march of civilization.

Adaptability of Trout. In spite of definite limitations as regards the chemical and biological features of their environment, trout are, on the whole, amazingly adaptable. So long as it can get enough oxygen, is not overheated or over-chilled, and can find enough to eat, a trout is usually perfectly happy. The types of water that will support trout are numerous and of very dissimilar appearance, both superficially and biologically. What, for example, could be more different from a Scottish burn than a Middlesex gravel-pit ? Yet one could move trout from Scotland to Middlesex with confidence that they would adapt themselves quite rapidly to the changed environment.

Movements of Trout. Most people have noticed how a particular trout will stop in one place for a whole summer. Whenever they pass by, he will probably be there, unless temporarily absent through fright. A trout will seek out and hold (if he is strong enough, or fortunate enough) a position appearing to him to be a favourable place from the point of view of security and, more particularly, one that will enable him to acquire the maximum amount of food with the minimum of effort. During the spring and summer, the chances are that he will not move very far away from one definite (and often very small) area of the stream or lake in which he fiinds himself.

During the late autumn, however, if approaching maturity, or of mature age, he will become restless and may travel fȧr. How far he will go will depend upon the conditions prevailing at the time. Obstructions, or lack of water, will shorten his journey, but he will almost invariably travel upstream in search of suitable shallow water in which to spawn. After spawning, he will gradually drop back. He may return to his old haunts, or he may be prevented from doing so by some change in the water level, or by some alteration to the bed of the river.

Trout usually commence their lives in the upper reaches of streams and gradually fall back—searching for richer feeding and deeper water—downstream as they get older.

Lake trout will try to run up feeder-streams during the autumn and winter ; or if there are no streams, they will work round the shores seeking conditions where the set of wind-currents and type of bottom make suitable spawning-grounds.

Other movements of trout may be caused by floods, drought, deteriorating quality of water, or shortage of food.

Vision. The ability to see, is one of the trout's most important senses, if not the most important. It captures its food chiefly by its sense of vision. It recognizes enemies visually and, if it sees them soon enough, is often able to escape capture. From the fisherman's viewpoint, his sport is entirely dependent upon the trout's ability to see. Trout have monocular vision and are rather short-sighted. It seems almost certain that they can recognize different colours ; if they cannot, the many hundreds of trout flies of varying hues become meaningless. There is no doubt that they are able to see quite well after dark, as trout will take flies long after the angler is unable to see the rise. A trout's angle of vision is about 48½ degrees on each side of the perpendicular. A trout lying one foot below the surface can see a circular area of water approximately 27-inches in diameter. At 2-feet deep, it would see a circle approximately 54-inches in diameter. If only 2-inches below the surface, its circle of vision would only be about 4½-inches in diameter. The deeper a trout is lying, the more it sees, subject to a reduction in the intensity of light reaching it, this varying as the square of the depth.

Free-Rising Trout. There is no doubt that some trout are more disposed to feed freely at the surface than others. The inclination to rise is, necessarily, stimulated by the quantity and quality of surface food; in other words, trout cannot be expected to rise if there is no hatch of duns, or no spinners returning to the water to lay eggs. The reason why trout take the mayfly well on some waters is because, for a few weeks of the year, better feeding can be obtained on the surface than down below. Once the mayfly is over, easier feeding is usually obtained among the weed-beds, by way of fly larvae, shrimps and molluscs. Chalk-stream trout, where the feeding is rich and varied, appear to be more prone to bottom-feeding than the trout of faster rain-fed waters, where nymphs and flies form a higher percentage of the diet. It seems to me that there is some evidence that chalk-stream trout rise more freely, if, during the middle and latter part of the fishing season, the weeds are kept rather more closely cut than is commonly the case. On a number of occasions, I noticed how dour certain stretches, with which I was familiar, tended to become after midsummer; yet how the trout would wake up and feed on surface food as soon as the weeds had been cut. Possibly too much stress has been laid on discrimination in the matter of weed-cutting in most books about fishery management. A better plan might be to cut a little more weed during July and August. On many waters, weed-cutting takes place chiefly before June and then, very often, nothing more is done until the autumn.

Non-rising Trout. Dr. Barton put forward an ingenious theory—and I fancy it is certainly partially correct—in his book *Running Water*. Dr. Barton maintained that the surface-feeders, those with inherited interest in surface food, gradually become exterminated by dry-fly fishing, the fish remaining, being those with an inherited preference for subaqueous food. He wrote: "If a scientific specialist on practical genetics were challenged to produce in a river a race of trout which avoided the floating fly, he would go about it in exactly the same way as we are doing, save that he would not trifle with a rod, he would take a gun to it. That is, he would destroy any fish rising to the fly and allow only those to breed which did not rise; thereby in time removing the strain and cultivating a non-rising stock.' The significance of this theory is today largely minimized by the fact that most waters are so heavily fished that large introductions of artificially-reared trout have to be made to enable the standard of sport to be maintained. On waters never, or seldom, stocked with trout, the continual capture of trout with the dry-fly must, inevitably, so it would seem, diminish the percentage of potential surface-feeders.

Length-Weight of Trout. Various tables have been published during the past, showing the relation of weight to length. Variations are due to different workers using trout from different localities for acquiring their information; another source of variation is that some measure trout from the tip of the snout to the fork of the tail; others from the tip of the snout to the extremities of the tail.

The table I use myself, based on large-scale measuring and weighing of artificially-bred trout, is given below; though I do not often need it exactly in the form given here, the weight of a thousand trout being more useful for commercial work.

Length in Inches (overall)	*Weight (ounces)*
3	0.16
4	0.355
5	0.665
6	1.271
7	2.185
8	3.6
9	5.04
10	7.12
11	9.68
12	12.51
13	14.93
14	18.0
15	22.99

Sturdy's Scale commences at 9-inches, the weights being slightly less than those given above up to 14-inches, which Sturdy gives as being 1 lb. 3 ozs.

Hewitt (*Trout Raising and Stocking*) gives slightly lower weights for 3-inch to 7-inch trout. He then jumps to 4-ozs. for 8-inch and 6-ozs. for 9-inch (which would be very exceptional fish).

The Natural Reproduction of Trout. In an earlier chapter, I drew attention to the importance of flow of water in connection with natural reproduction, suggesting that a minimum rate of 2-feet per second is selected, for preference, by the trout, since, at that velocity, redd-making is easier and the size of the bottom particles more suitable for the purpose. I also mentioned that trout (and salmon) alone among aquatic creatures, choose the winter (Nov. —Jan.) for their spawning operations. In the same chapter, I mentioned the effect of floods on trout ova and fry : how ova may be jarred, silted-up, or suffocated, and fry choked by fine silt getting into their gills. I also pointed out that lack of rainfall in the autumn can delay spawning operations, preventing trout from getting up the burns and tributaries, how a winter drought can expose trout-redds and cause loss of ova through exposure to air and frost. Later still, I gave some information about the effect of temperature on the incubation of trout ova and how cold water retards hatching and warm water accelerates it.

Having brought these points once more to the notice of the reader, there are a few more items connected with the reproduction of trout worthy of inclusion here :

Conditions necessary for reproduction to be effective : Flow of water at a good pace and bottom materials the size of nuts, create a favourable environment for the construction of redds and for the subsequent incubation of the ova. The water should be absolutely pure (and invariably is pure in streams where the reproductive rate is high) and well-oxygenated. The spawning area must be extensive in relation to the numbers of pairs of breeding trout involved. The number of ova fertilized during spawning must be reasonably high ; conditions during the incubation period must remain reasonably stable, namely the flow of water must be maintained and redds disturbed as little as possible. Probably of even greater general importance are the conditions greeting the alevins and fry subsequent to hatching. Absence of enemies and an adequate supply of food may well have more bearing on the effective reproductive rate than any other factors.

The modern view is that the percentage of ova fertilized is of a high order and that most of these ova hatch. This view has gained ground in recent years largely due to the publication of the results of investigations carried out by Mr. Derisley Hobbs in New Zealand. New Zealand is still to a large extent an uncivilized country and most of its streams are pure, isolated, extensive and free from tampering by human agencies. Amazing success has, in the past, resulted from the shipment of trout ova from Britain to many parts of the world, including Australia, New Zealand, Tasmania, Kenya, Tanganyika, South Africa, India, Ceylon and other places which previously had no trout at all. The probability is that any virgin water of suitable temperature-range, rate of flow and type of bottom will give excellent results. There is now the possibility of introducing Brown Trout to some of the streams in Nyasaland. A small consignment of Brown Trout ova sent by air to Cyprus in December, 1950, and laid down in the mountain streams resulted, a year later, in favourable comments being made in the press as to the way they had grown.

In Britain, however, results are extremely variable. The best breeding waters are found in hilly country, such as Devonshire, Wales, Yorkshire and many parts of Scotland. Fast-running streams in large tracts of wild country, where there may be scores or even hundreds of miles of spawning-grounds, where human populations are small and where no obstructions other than natural ones bar the passage of trout, are those that breed most trout. In the Midlands and South Country, conditions are, however, no longer favourable. The extent of suitable spawning area is small ; the concentration of human beings is high ; very few rivers are not littered with obstructions in the form of mills, weirs, sewage and industrial-disposal plants, mutilated water-courses and so on and so forth.

Even under the most favourable conditions it can, I think, be proved by elementary mathematics that losses at one stage or another are inevitably extremely high. For the trout population in any stream to be maintained, it is necessary that every mature trout should reproduce itself. Assuming an equal proportion of males and females (a recent count I made, involving 1,360 four-year-old trout, produced 745 males to 615 females) the female trout has to replace herself and her mate. If better results than this were obtained, the stock of trout in the water would increase. The breeding females in the type of water where reproduction is good are not very large and produce about 500 ova apiece. Of these 500, only 2 are required to come to maturity to insure the maintenance of the stock at the same level ; and this computation does not take into account the fact that trout may easily spawn four or five times during their lifetime. Thus 498 out of 500 ova are doomed to extermination between the time they are laid in the redd and the time they reach maturity. That involves a loss of 99.6 per cent. and a survival-rate of only 0.4 per cent. In the case of chalk-stream trout, where the egg-yield may average about 1,500 per female, the loss will amount to no less than 99.86 per cent., with a survival-rate of only 0.14 per cent. These figures do not allow for any fishing. It seems to me almost certain that every mature trout caught on the rod not only means one less fish in the immediate future, but also one fish less on a permanent basis. I am not prepared to give an opinion as to precisely when, how, or in what proportion at various stages, these losses take place. It is quite certain, however, that losses on this staggering scale occur and I incline to the view that losses materially recede in scale as growth towards maturity proceeds : in other words that the bulk of the loss occurs either during the egg or fry stage. This belief is, to some extent, supported by the fact that stocking with ova or fry in waters already containing a natural stock of trout appears to have little or no effect. If trout are entirely absent and conditions are in other respects favourable, such stockings are sometimes remarkably successful, where carried out on an adequate scale. This line of reasoning points, unmistakeably, towards the trout itself as the prime exterminator of young trout and it seems to me quite conceivable that Nature makes use of fry and young trout to convert microscopic food into a form usable by larger fish.

Effect of Fishing on Reproduction. What is the position at spawning-time in waters where fishing is carried out on any considerable scale ? Most fisheries conform to size-limits and the best fish are retained by the angler. This means that the stock of breeding fish is reduced by the amount of the bag and, furthermore, that smaller and younger fish are left in the water to breed. Not only is the angler directly reducing the stock of trout, but he is also impairing the quality of the breeding stock by killing off many of the finest specimens. Hatchery work has shown, conclusively, that the largest fish of a particular generation will have the capacity to produce larger, faster-growing fish, than will smaller parents.

Conclusion. This chapter and the two preceding ones have mainly been concerned in skimming over some of the basic problems connected with trout and really serve as a rather lengthy introduction to the remainder of the book.

The following chapters attempt to give some practical advice on how trout fishing may be developed and what is already being done.

CHAPTER 4

On Estimating the Quality of Waters

NUMBERS of keen trout fishermen, up and down the country, are interested in the possibility of developing waters on their farms and estates as trout fishing. Others, dissatisfied with odd days fishing here and there, are looking about them with a view to obtaining water of their own : water suitable to stock with trout and provide them with reasonable sport at a cost within their means.

Few are able to decide, however, when a possible water comes within their reach, whether the risk of taking it on is justified, or how to set about an estimation of its worth in terms of future sport.

In this chapter, I have, by giving some general advice and dealing with a number of examples, tried to show how any water may be examined and how a decision, one way or the other, may be reached.

Types of Water. Broadly speaking there are about twenty types of water likely to be met with in Britain. In some of these, trout may be indigenous ; in others, trout may, under favourable circumstances, be introduced. These waters may conveniently be summarized as under :

Bournes ; small chalk-streams ; large chalk-streams.
Becks ; brooks ; burns ; moorland streams ; small rain-fed rivers ; large rain-fed rivers.
Limestone streams.
Canals.
Natural ponds; artificial ponds; ornamental ponds; moats.
Tarns; small lochs ; large lochs.
Small natural lakes ; large natural lakes ; small artificial lakes ; large artificial lakes ; reservoirs.
Quarry-ponds ; gravel-pits.

Classification and General Appearance. Having got to know of a possible water, either from a friend, from an advertisement in the daily, local or sporting press, or in the devious ways in which the information that a water is to let, or to sell, comes to light, the first thing to do is to make arrangements to go and look at it. It is usually quite hopeless to rely on agents' descriptions, letters from owners and so forth. The only sensible thing to do is to go and see it and make as careful an investigation as possible, within the limitations imposed by the short time usually available.

By the time the water is reached, information of some kind has usually been acquired. For example, the water will probably have been put into its proper category, such as artificial lake, chalk-stream, or whatever it may be. We should go prepared to ask a lot of questions, to listen carefully to everything that is said and to observe and remember as much as possible.

Usually, the owner, or his representative, will be there to give any information within his capacity, to point out boundaries, rights-of-way and other matters of general interest. If he is keen to let the water, he cannot fail to be enthusiastic about it (unless he is a very poor salesman) and it may be necessary to discount a certain amount of what he says. For instance, if, in answer to our question : 'Does this stream ever flood?' his reply is in the negative and we can see a lot of flotsam caught up in the bushes several feet above the water-line, we may be reasonably certain that either his knowledge of the stream is meagre, or that he is, for some reason known only to himself, anxious for us to believe that the stream is immune from flooding.

The first task then, is to walk the whole length of the water, if a stream, or right round the perimeter, if a pond or lake. As we go along, we take careful note of everything we see and ask as many questions as possible.

Things we want to know include the following :

Are trout already present ? If so, where are they ? How big do they run and how many of them are there ? Are there any other fish ? If so ; what kinds and how plentiful are they ? In particular, are there any pike ? Do herons, otters, or other predatory creatures visit the water ? If there are no fish at all, what is the reason ? Has the water been fished before ? If so, what is its past record in terms of fish caught ? Is there any known or possible major source of pollution ? Where does the water come from ? What villages, towns, factories, etc., are astride it ? What is the surrounding country like ? Does the water ever dry up ? What are they neighbours like ? Do they look after their fishing, or is it neglected ? In short, we endeavour to absorb as much local knowledge as possible and to form a picture in our mind of what the water will be like at all seasons and under all sorts of conditions.

Such questions may seem elementary ; but neglect to ask them may well give subsequent cause for regret. Even the most elementary considerations can lead to an early termination of our visit. If, for example, we discover that the whole village is accustomed to come and bathe on every warm Saturday and Sunday during the summer, we should do well to say farewell and seek out some other water free from traditional bathing-holes. Similarly, we should hardly consider renting a stream where the owner confesses that he regularly dips his sheep. Too often, these little seemingly irrelevant matters, can make all the difference to future results from the angler's point of view.

After absorbing as much general information as possible, the next step (assuming that our impressions, thus far, are favourable and that there are no obvious deterrents, like fierce bulls in every field, or farmyard ducks paddling about wherever we look) is to try and find out whether trout will live in the water and how well they are likely to do.

Water Supply. The following points are important. Note the rate of flow of the water (if a stream), bearing in mind the time of year and the amount of recent rainfall. Try and decide how much of the water is due to springs and how much to drainage from the surrounding land. Take note of the colour of the water, whether clear or turbid. Obtain a good idea of the area of water involved and its depth at various points. Make a careful inspection of all hatches, spillways, penstocks, dams, embankments, etc., with a view to ascertaining their state of repair and serviceability.

Collection of a Water Sample. It is usually desirable to take a sample of the water for analysis, since much can be learnt about the quality of the water as regards purity and potential productivity. Winchester quart bottles (which hold about ½-gallon) are most suitable for this purpose, preferably with glass stoppers rather than corks. Samples should be taken at all sources of supply, such as tributary streams, so that comparisons in the quality can be made. In the case of a short length of stream or river, one sample taken at the upper boundary should be adequate. For longer stretches, one at the top and one at the bottom boundary (in addition to any appreciable tributaries) will be desirable. Where ponds and lakes are concerned, one sample, taken at any convenient point, should serve, unless there is a stream running in, in which case a sample should be taken at the inlet and another at the outfall.

Before filling a bottle, give it a rinse with water from the pond or river ; then, holding it upright, immerse it completely beneath the surface until quite filled, taking care not to disturb any sediment or mud. Stopper the bottle tightly, excluding all air bubbles. Take the temperature of the water at the point of sampling and make a note of it on a label attached to the bottle, together with particulars of the name of the water, the date and the exact place where the sample was taken. A strong wooden box with partitions for holding several bottles is desirable for the safe transport of water samples. The water should be analysed as soon as possible after collection and, in any case, within 48 hours, otherwise changes in its character may easily take place.

Scope of Water Analysis. Anything like a complete analysis of a water sample is usually quite unnecessary. To get out a full analysis will involve several days of laboratory work. Even the essential (or desirable) tests will normally take anything from 3 to 5 hours work by a person thoroughly conversant with the various techniques and with all the apparatus and chemicals ready to hand.

The following list of determinations comprises those most useful for fishery work. Needless to say, in cases where pollution is confirmed and any remedial action contemplated, a more complete analysis, or a series of analyses will be necessary. In the vast majority of cases, however, we are concerned more with placing a water into a particular category as regards suitability for trout, than with pollution. A grossly polluted water has, in any case, to be written-off from the fishing point of view, at any rate until the position has been rectified, which may involve a period of years.

Dissolved Oxygen : Oxygen, being absolutely essential to the existence of trout, it is desirable that any water into which they are to be introduced should be fully oxygenated. Waters less than 75 per cent. saturated should be given very careful consideration in the light of all other available and relevant information. See table of oxygen-saturation in water at various temperatures in Chapter 2, page 34.

Oxygen absorbed (bio-chemical oxygen demand) : This is another very useful test and gives an indication of the amount of decomposing organic matter in the sample. It is based on the amount of oxygen absorbed, in a given period, by a measured amount of the sample from a solution of potassium permanganate of known strength. A very pure water may only absorb 0.001 parts of oxygen per 100,000. Most good trout waters absorb from 0.05 to 0.01 parts of oxygen per 100,000. Anything above 0.2 p.p. 100,000 indicates pollution to an extent likely to make the water unfit for trout. A water under-saturated with oxygen will often have a high figure for oxygen-absorbed.

pH (Hydrogenion concentration): Another useful test and a factor that it is always desirable to know. Neutral water has a pH of 7.0. Above that point it is alkaline, below, acid. Acid waters are usually poor producers of trout of large average size. Some of the best breeding streams are acid and contain numbers of very small trout. The alkaline waters are usually the best producers, but it does not invariably follow that because a water has a high pH it will grow large trout. It is rare to find waters much more acid than pH 5, or alkaline ones exceeding 8.5. Most of the best waters range from pH 7 to pH 8 and, in the chalk-streams, the average is about 7.6. The time of day and the time of year will often have an effect on the pH reading, particularly from ponds and lakes with much vegetation. In such waters, more particularly during hot weather, there is often a very marked diurnal variation, the highest readings being obtained in the evening and the lowest soon after dawn. This variation is usually connected with a similar rise and fall in the oxygen saturation level and the amount of free carbon dioxide.

Conductivity. The electrical conductivity of a water depends largely upon the amount of matter dissolved in it. The conductivity of pure and sterile waters is low, that of fertile, more productive waters, higher. Polluted waters may be very much higher still and there are some areas in the country where high conductivities are due to enormous quantities of salts in solution (usually sulphates, chlorides and carbonates). In my experience, trout waters range from about 50 to 600 units, the lower figure being obtained in many Devonshire, Welsh, North

Country and Scottish streams and lochs and the higher figure in the more fertile rivers and lakes of the South Country. A favourable conductivity range for satisfactory growth appears to lie between 300—600 units. (The unit used is the reciprocal of the megohm). Several Bedfordshire gravel-pits, with conductivities running up as high as 2,500 units, have been successfully stocked with trout, but such high readings in unpolluted waters are most exceptional.

Hardness: One degree of hardness corresponds with 1 part of calcium carbonate per 100,000. Hard waters are usually the best producers of trout and a useful range is from 15—30 degrees. Burns and hill streams and ponds and lakes in soft-water districts are often under 8 degrees of hardness; whereas chalk-streams vary from 25—35 degrees. Shellfish, crayfish, shrimps and many other rich sources of trout food, are only found in quantity in reasonably hard waters.

Free and Saline Ammonia: Most natural waters contain small quantities of ammonium salts, usually in the form of ammonium carbonate. This can be 'freed' by distillation and measured by titration. Most reasonably pure waters do not contain more than 0.005 parts of ammonia per 100,000, much of which is due to natural sources derived from rain and the soil. Appreciable amounts are usually due to pollution by sewage, cattle, drainage from manured farmland, etc. Whenever an abnormal amount of 'free' ammonia is present, the figure should be considered in conjunction with those for dissolved oxygen, oxygen absorbed, chlorine, etc. High figures for ammonia, chlorine and oxygen absorbed, coupled with a deficiency in oxygen, will almost certainly indicate pollution of a damaging nature.

Albumenoid ammonia: This is determined by estimating the amount of ammonia produced by the decomposition of the ammoniacal organic matter, by adding alkaline permanganate to the water remaining in the still after completion of the previous test. This organic matter is derived from decaying vegetation, decayed or decaying bodies of innumerable aquatic creatures and other organic debris. Results obtained will usually vary from 0.01 to 0.1 parts per 100,000, according to whether the sample contains little or appreciable quantities of organic matter in it. High figures for albumenoid ammonia tend to indicate recent contamination. The actual results are of slight value, since the quantity of organic matter from week to week is never static, fresh matter being added at a variable rate and 'older' matter being broken down into carbonic and nitric acids.

Chlorine : Usually present in varying amounts in the form of sodium chloride, an excess of chlorides in a sample indicates pollution by sewage. It is essential to have an idea what the normal chloride content is for a particular watershed : otherwise, what may appear to be a polluted water may actually largely contain chlorides from natural sources. Taken in conjunction with other tests, a high chlorine content indicates recent or existing pollution by sewage or animal excreta.

Nitrites and Nitrates : Nitrites are formed by sewage during the process of decomposition. As nitrites are rapidly oxidised into nitrates, the presence of the former usually indicates pollution of a serious nature. It is very rare to find even a trace of nitrites in any water suitable for trout. In a healthy river or lake, nitrates are very rapidly taken up by algae and plants ; more than a trace of nitrate found in a sample will usually indicate fairly heavy organic pollution, particulary in a heavily weeded water.

Residue : It is often useful to evaporate a small quantity of the sample in a nickel dish (25 or 50 c.c.) and to note the type of residue remaining. In a good trout water, all that will remain will be a film of white powder on the bottom of the dish. If much organic matter is present, charring of the residue will take place and the deposit will become brown or black. At the same time, it is often possible to smell the pungent fumes of ammonia given off during the process of evaporation.

Colour : The best trout waters are practically colourless.

Turbidity : Satisfactory water is usually perfectly clear and bright. Turbidity may be caused by various substances, some harmless, some of a harmful nature. A turbid water should always be carefully examined and, for the most part, they will not be very good trout waters.

Interpretation of results of water analysis. The above notes give a basis for the interpretation of results obtained from analysis. On their own, however, they are of slight value. It is perfectly possible to have an admirable water from a chemical point of view, but one which will not be fit for trout. The key to practical interpretation is to corelate figures obtained from analysis with visual factors. A man who has had wide experience of this sort of work is able, to an appreciable extent, to form a very good idea of the quality of a water—from the fishery aspect—simply by taking careful note of what he sees. If, for example, trout are already present, a rather doubtful water analysis would not, necessarily, justify condemnation. He is able to tell, by noting the appearance of the water, the aquatic vegetable and animal life, depth, nature of bottom, and the general condition of the particular river or lake concerned, what the prospects of making satisfactory trout fishing are likely to be. A water analysis will probamly confirm his general impressions, but as it is always possible to be in error, there is rarely any justification for omitting to take a water sample and having it analysed.

Water Plants. A note should always be made of any aquatic vegetation present, paying particular attention to those plants which are the most prevalent. Much can be learned from these, since, by the type of flora existing in a water, it is often possible to form a very fair opinion of the quality of the water from the point of view of trout fishing. A pond over-run with water-lilies, or pondweeds such as *Potomageton natans,* will probably prove, after further investigation, to be unsuitable for trout ; whereas, if nice clumps of starwort, celery, hornwort or *P. densus* are noticed, the possibility of the pond being a good producer of trout food and trout is much more likely. Waters can be grouped, very roughly, by the type of plants they are able to maintain. Some plants need alkaline water ; others prefer acid conditions. Some are fast water plants ; others live in sluggish water. Some live in shallow water and some in deep. A complete list of plants would be out of place here. It is only necessary to emphasize that plants are most important ; that different types of water support different types of plant ; that some plants are more valuable than others ; and, in general, the richer the aquatic flora, the richer will be the food supply and, consequently, the greater will be the number or size of the trout a particular water can support.

Food Supply. A rough estimate of the available supply of food should always be made. This can be done by searching weed-beds, etc., with small dip-nets of fine mesh. If necessary, a collection of the various insects, crustacea, molluscs and other creatures can be made and transferred to a jar or other suitable receptacle for more careful examination at a later hour. Usually, however, it is possible to establish very rapidly what forms of life are most prevalent and what beneficial species are lacking. After some considerable experience, it is not difficult to form an estimate of the total bulk of food present, even with just a few sweeps of the net. Those interested, are referred to 'Life in Rivers and Lakes' by T. T. Macan and E. B.

Worthington, which gives detailed information about life in freshwater and the relation that each bears to its fellows.

As in the case of plants, it is possible to place a water, fairly accurately, in terms of potential production, by the fauna inhabiting it. Waters containing only low forms of life will be less productive than those with a more advanced fauna. A productive trout water is entirely dependent upon the richness of the crop of insects, molluscs, crustaceans and other animals capable of sustaining trout. Therefore, when attempting to assess the possibilities of any water for trout fishing purposes, a rough-and-ready survey of its aquatic life should never be omitted.

Fishery consulting work. There is only a handful of persons in this country who are consulted professionally in relation to the development of trout fisheries. The reason is largely an economic one. The amount of work in any one district is insufficient to enable any trained chemist or biologist to operate independently, fees paid for this sort of work being inadequate to maintain anyone on a full-time basis. A really thorough chemical and biological survey is economically out of the question, since months or years of study would be required to get anything approaching a comprehensive picture.

Most of this work therefore falls to a few commercial trout farmers, who are able to afford to do it as an interesting side-line. Out of their fees they have to purchase and maintain a considerable amount of apparatus ; they may be called up to motor several hundreds of miles and be away from home for a night or more ; while, on their return, the material has to be analysed and a report prepared and sent off. It is usually impossible for a busy trout farmer to do more than fifteen or twenty of these examinations in the course of a year. Each of them may occupy his mind for several days and interfere with his normal work to a considerable extent. It is true that he is sometimes compensated by getting orders for trout ; but if he values his reputation he will not allow his opinions to be tempered in any way by considerations of that nature.

Less than a year ago I was looking at a lake in company with the owner and before I had been there very long he turned to me in amazement and said 'Don't you want to sell me any trout then?' I told him quite plainly that the fee he was paying for my advice entitled him to a perfectly candid and unbiased opinion. I had not come over to sell trout, but to try, to the best of my ability, to let him know whether the lake was suitable or not. In my view, for a number of reasons, it was not. Incidentally, he did not take my advice. Within a fortnight of my visit he had stocked it with £50-worth of trout. Apparently the results satisfied him, as he has since placed an even larger order, not only for this year, but for next as well. I never mind making mistakes in that direction. Doubtless I sometimes advise stocking in cases where subsequent results are inconspicuous ; but never, in the course of examining and reporting on some hundreds of waters in most parts of the country, have I been reproached with giving misleading advice, though I am well aware that I may have deserved such reproaches more than once.

Summary of main points in estimating the quality of a water.

1. Pay careful attention to superficial appearance.

2. Obtain as much local information as possible.

3. Make notes of variety and quantity of aquatic flora and fauna. Find out what fish (if any) are present.

4. Find out where the water-supply originates, noting any likely sources of pollution.

5. If having a sample analysed, the following are likely to be the more important factors :
   - (a) Fully oxygenated waters are usually safe for trout. Waters under-saturated with oxygen are frequently unsuitable.
   - (b) Hardness and alkalinity in a water usually indicate a capacity for high production.

6. Careful consideration should be given to the physical requirements of trout as regards the following :
   - (a) Rate of flow.
   - (b) Type of bottom.
   - (c) Effect of possible floods or droughts.
   - (d) Temperature-range likely to occur.
   - (e) Depth of water : proportion of shallow to deep water.

Specimen Report. The following report on a small lake is included with the object of showing how the various information obtained by inspection may be co-related ; and the method of reasoning by which an opinion may be reached.

Dear Sir,

With reference to my visit to your lake, I now have to report as follows with regard to its potentialities as trout fishing :

1. General Description : The lake is fed by a small spring-fed stream, which normally carries a somewhat meagre flow of water, doubtless running more strongly after rain and during the early part of the year when the output from the springs is at its peak. It is liable to fail, or at any rate to become reduced to a trickle, during the summer. The stream runs through wooded country.

There are a few water plants in it, including Water Starwort (Callitriche), Watercress (Nasturtium), Water Celery (Apium) and Brooklime (Veronica). There is little in the way of insect life, though a few larvae of olives or pale wateries were found; also several freshwater shrimps.

The lake is heavily surrounded by trees and rhododendron bushes. There is also a heavy fringe of reeds and some reed-mace (Typha), reducing the area of the lake by about one-quarter, or perhaps a little more. The water is clear and of moderate depth, with a reasonably firm bottom. The predominant water plant is Milfoil (Myriophyllum). There is also some Floating Pondweed (P. natans) and one of the Hair-Leaved Pondweeds. At the time of examination there appeared to be little in the way of animal life. A few Water Louse (Asellus) were found and a considerable number of Corixa: a water-bug. No snails of any kind were found. Coarse fish (so you informed me) were numerous, consisting of carp, tench, and perch, some of considerable size.

Superficially the lake does not have the appearance of a Trout Lake. At first sight one would, definitely, put it into the 'coarse-fish lake' category. However, some success appears to have been obtained with the Rainbow Trout put in last spring. These are reported to have shown up well during the early months of the summer, rising freely to midges in the evenings, and to have made some growth. Later in the summer—an exceptional one for low rainfall and high temperatures—very little of them was seen and their present fate is unknown.

2. *Examination of Water Samples:* A sample of water was taken at the outfall of the lake, having a temperature of 41 degrees F. Another sample was taken from the stream by the road bridge. This was 2 degrees F. cooler. Results were as follows:

	Lake	*Stream*
Colour	Slightly yellowish	Slightly yellowish
Odour	Nil	Nil
Residue on evaporation	Considerable, with charring on combustion	—
Iron	Nil	Nil
Hardness as calcium carbonate	10.0 p.p. 100,000	10.0 p.p. 100,000
Chlorine	5.5 p.p. 100,000	5.5 p.p. 100,000
Nitrates and nitrites	Nil	Nil
Free and saline ammonia	Distinct trace	Heavy trace
Dissolved oxygen	Fully saturated	Slightly under saturated
pH	6.4	6.4
Conductivity	180	180

There is no significant difference between the water of the stream and the lake. Both are soft and acid. There is a little pollution, probably due to animals visiting the stream to drink and to waterfowl.

From the point of view of supporting the better kinds of trout foods—such as snails and shrimps—it cannot be considered to be at all favourable, being too soft and acid and, at the same time, rather stagnant. It is improbable that trout would grow well in it, in its present state, but it is possible that they might do better than anticipated.

Owing to the small inflow of water, there is a good deal of danger of the water becoming de-oxygenated during hot weather (at night), particularly if the weed-growth is rampant. This is less likely, perhaps, in that soft water inhibits the growth of green algae : a likely cause of de-oxygenation, when conditions become hot and the water rather stagnant.

Shelter from trees and bushes reduces the risk of overheating of the water, but, at the same time, limits the amount of light reaching the lake. Fallen leaves, lying on the bottom, do not provide a favourable habitat to many creatures, except the lower forms of life such as infusoria, worms and leeches, together with mosquito larvae, and they also rot down and produce mud. In rotting, oxygen is required and this can only be obtained from the water.

The quality of the water might be improved by the application of powdered chalk. Up to 10-cwt. per acre, spread from a boat, should help to neutralize the acid in the water and produce conditions more favourable to the higher forms of aquatic life. The stream might also be limed with advantage, but in this case lump-chalk spread on the bottom would be preferable to powdered chalk.

Removal of the coarse fish will also help considerably to provide more food for the trout. These compete heavily with trout for food and are very prolific. Netting alone will not eliminate them. Drainage of the lake would be the most effective method. After salvaging as many of the coarse fish as desired, it would be a good plan to dress the exposed surface of the lake-bed with quick-lime. This would make certain of killing all small fish and fry remaining in the mud. The slaked lime would subsequently fertilize the lake and promote better conditions.

3. *Stocking with Trout:* I am unable to advise you to stock heavily with trout in the immediate future. In view of the relatively poor quality of the water, it would be most unwise to do more than put in a trial lot of fair-sized Brown Trout. As I suggested at the time of my visit (and to which you agreed) I think that 75 11-inch Brown Trout will give you a good idea of what can be expected in the way of growth and, should any or all of them die for any reason, you should have no difficulty in recovering some of the corpses for examination. Smaller fish could be used, but yearlings would be liable to be eaten by the perch. Big trout—such as the three-pounders formerly on order—would almost certainly fall off in condition.

Little will be lost by proceeding slowly in this matter of stocking. Should these trout survive and put on reasonable growth, or at any rate hold their condition, there will be no difficulty in adding to the stock the following year, with far less risk of heavy financial loss.

4. Letting of Rods : My opinion now is, having seen the lake, that it is not really the type of water for letting as trout fishing. So far, it is not known what results with trout can be obtained, so that letting in the immediate future is out of the question. I do not say that the fishing cannot eventually be let. No doubt it can, the demand for trout fishing in the South of England being greater than the supply, but its value would be entirely dependent upon how well trout will thrive in it. If trout can be made to live and grow reasonably well, it might be possible to get a fair return from the fishing by stocking with sizeable trout on an annual basis. The expensive single rod at £120 per annum, as advertised, seems altogether too much to expect ; though I would not doubt that £120 could be got in from three or four rods paying proportionately less, assuming always that the initial trial-stocking shows that further development can be justified.

It is impossible to forecast what the effect of making additional lakes would have. An increased acreage is desirable from the fishing point of view ; but it does not seem worth while to make further lakes until the present one has been thoroughly tested out and shown that it can support trout. Needless to say, there is no reason why the lakes should not be made, if required for purposes other than trout fishing.

I am afraid this is a rather gloomy report ; but I cannot do more than give you a fair opinion. No doubt there will be an opportunity of looking at the lake again during the spring or summer. Also, I shall be only too pleased to do what I can to help you at any time, if you care to keep me informed about what is going on.

Yours sincerely,

(Signed) L. R. PEART.

Conclusion : The successful appraisal of waters for trout fishery purposes is largely a matter of training and long experience. Scientific training of as wide a nature as possible is obviously an advantage ; but practical knowledge of the requirements of trout under all kinds of conditions counts for a great deal. The object of this work is, after all, to enable as many waters as possible to be developed for trout fishing. A man with much scientific knowledge but insufficient practical experience, is likely to get bogged down in a welter of hypothetical contradictions. Confidence can only be gained after examining scores of different waters and in the realization that a major part of the advice given on previous occasions has successfully matured.

CHAPTER 5

On Ways in which Trout Waters May be Used

FEW will disagree that there are more people interested in trout fishing than ever before in our history. In spite of this, there is no doubt at all that hundreds of miles of river and stream and numerous lakes and ponds in every part of the country are contributing very little—and many are contributing nothing at all—towards easing the general demand for fishing, or easing the pressure on those waters already being too heavily fished.

What are the reasons for this regrettable state of affairs? There is still a surprisingly large number of owners who barely appreciate the fact that useful streams run through their property, or that they possess what might be excellent fishing in ponds and lakes. Possibly they are not fishermen ; or, perhaps, they are only interested in catching salmon from somebody else's river. Some of this fishing is let for what it will fetch ; others, not needing the rent, or for personal reasons of their own, will not let at any price.

All potential trout water is, indeed, owned by one of four classes of proprietor. These may, briefly, be classified as follows :

(a) Is not interested in what happens to it.

(b) Does not realize that he owns something that many anglers would give almost anything to possess.

(c) Does a little spasmodic fishing himself; may let his friends fish; or may lease it for what it will fetch. In any case he does little to get the best from the water.

(d) Thoroughly appreciates the fact that he owns somethings worth having and spares no effort or expense within his means to develop its capacity to the full.

Fortunately, classes *a* and *b* are becoming rarer. Estate agents are helping to open the eyes of owners to the fact that fishing is a valuable capital asset. One has only to glance through the property-market advertisements in country and sporting newspapers to note the heavy type used to draw attention to the fact that a particular place has even the merest trickle of water running through it. Class *c* includes the majority of owners in this country; while class *d* owners—those who really make the most of their waters—are still lamentably few.

Anyone who doubts the above is invited to compare the various stretches of any river with which he is reasonably well acquainted. He will find, I believe, that development is of a very patchy nature: that some owners do nothing; that more do a little; that very few do as much as they might.

While few people—and I, certainly, am not one of them—would wish to compel owners to develop their fisheries, it will be of considerable benefit to the angling community, when all owners, whether fishermen or not, have fully learned that in the possession of water they have an asset by no means to be despised.

I have done something, in this chapter, to show how these waters may be utilized.

Private use by the owner. The development of trout fishing for private use is, in most ways, very much less complicated that when it is desired to derive an income from the water.

The first step, needless to say, is to form an opinion of the natural (or basic) quality of the water and to get an idea of its potentialities. Those with little knowledge, or experience, may well have to seek advice to settle this matter satisfactorily. The previous chapter deals in some detail with the problem of assessing the quality of a water and describes a method of investigation proved to be trustworthy in the majority of cases.

Assuming that the water is promising from the aspect of purity, probable productivity and so forth, there are several other important points to be decided.

Perhaps the first, is to come to a decision on the amount of money available for development and upkeep. Obviously, much will depend upon this. One owner might decide that he could afford no more than £10 per annum on running his trout fishing; another, with water of similar quality, might be prepared to spend £500, or even £2,000 annually. Both may be perfectly satisfied with their results: it is largely a matter of what their 'target' is in terms of sport.

Thus, in addition to coming to an early decision on expenditure, it is also necessary to have a clear idea of what is wanted in the way of fishing. Some anglers are quite happy with a very occasional fish. Some are miserable unless they can kill a dozen sizeable trout every time they go out. Some are satisfied with little trout of three-to-the-pound. Others are interested chiefly in three-pounders. While it is not always possible to realize ambitions in connection with the development of a particular water, ambitions of any kind are more likely to be realized, if a clear picture of them can be formulated in advance. A considerable amount of fishery development goes on in a more or less haphazard way, with little, if anything, in the way of fixed objectives. The man who says: "Here is my water. I want to be able to catch 200 good trout every season, averaging not less than a pound apiece" is more likely to achieve results than one who is hesitant and vague about it all. Far too frequently, owners adopt a hit-or-miss technique. They say: "I've got some water, too. It might be suitable for trout. I'll put in a few for luck and see what happens." Sometimes such people are agreeably surprised; more often, some unforseen factor operates detrimentally, with the fairly common sequel that the water is allowed, once more, to become derelict and forgotten.

At this stage, the wise man has, accordingly, settled the following points:

(i) That his water is suitable for trout. He should also have some idea of the class of water to which it belongs, namely, highly productive, mediocre or poor. In this connection, it is obviously out of the question to think in terms of big trout, should the water fall into the latter group.

(ii) He has also decided how much money he is prepared to spend annually on development and maintenance.

(iii) He has definite ideas on what he expects in the way of sport, viz., number of trout to be killed in a year and their average weight. To a considerable extent the realization of (iii) depends on the answers to (i) and (ii) and, therefore, all these factors are closely related.

With these three points clear in his mind, he is then free to proceed to practical methods of achieving his objective. This should be nothing less than sport at a certain level.

What are the main requirements in attaining a certain level of sport on any particular water? Quite simply they are as follows:

(i) The necessary number of trout must be provided in one way or another.

(ii) Conditions for fishing must be sufficiently good to allow the trout to be caught ; at the same time the angler, or his friends, must possess the degree of skill necessary to their capture.

The provision of the necessary number of trout is, of course completely tied up with the owner's decision on what he wishes to catch and how much money he is prepared to spend in achieving it. It may be that he owns a length of stream in the West Country, or some other natural home of trout, and that his 'target' is comfortably within the capacity of the water to sustain year after year, with very little effort or expenditure on his part. If so, he is, indeed, a most fortunate man. He owns, shall we say, for the sake of example, half-a-mile of fishing on the Dart or the Teign. He does not want to fish a lot ; he feels that he will be perfectly happy if he catches about one hundred trout of three or four-to-the-pound each season. The chances are that this is comfortably within the capacity of waters, such as these, to produce and maintain from season to season. But the next owner is not, perhaps, so modest in his demands. He, shall we say, owns three times as much water of similar quality ; but three hundred fish per annum—the same number of fish per unit length—will not suit him. He fishes four or five evenings a week and expects to catch five or six brace of trout every time he goes out, which means that the river is expected to find him more like one thousand trout each year. Obviously, this owner is going to be disappointed, unless he takes steps to increase the stock of trout to a level that will enable him to take 1,000 trout from a water which, in its present state, can only provide him with about 300.

What is there that he can do about this ? It is possible that an appreciable improvement in the output of trout may be made by intelligent methods of keepering. It may be that it is possible to make the water more attractive for trout, thus encouraging trout from adjoining stretches to take up residence there. It may be that vermin (herons, otters and the like) are taking a heavy toll of trout. Adequate discouragement of these may easily effect an improvement. Spawning facilities may be unsatisfactory and it may be possible to do something to insure that a higher proportion of ova deposited will survive. Improvements to the food supply would enable a greater weight of trout to be maintained.

Any improvements that can be made—assuming that they really are improvements from the trouts' viewpoint—should result in an increase in the number and size of the trout he will catch.

The effect of improvements may yet be insufficient to satisfy the wishes of this particular owner: the owner who wants to take 1,000 trout from a water formerly yielding about 300.

The remaining remedy is restocking. It is necessary to remember at this stage, (and for this particular example), that the stream is already producing as many trout as can be naturally supported. Therefore stocking with numbers of very small trout will do little good; they will merely compete for food with the existing stock and the net result may well be a smaller average. This, then, is a case where stocking with ready-made trout is desirable and they will, for preference, be turned into the river just before the commencement of the fishing-season. In this way, our owner, who will not be satisfied with a catch of less than 1,000 trout per annum, may be able to achieve his objective. Firstly, he will have the 300 trout naturally produced before he commenced to think seriously about fishing his own river. Secondly, he will harvest any additional trout resulting from improvements he has made. Thirdly, he will make up his bag to the 'target' figure with trout purchased from outside.

It is, therefore, possible in any water capable of holding trout, to raise the bag artificially, within the limits of commonsense and the amount of money available for the purpose.

The owner of a water estimated to be suitable for trout, but containing no trout at all, is in a somewhat different position. Every trout he catches will, of necessity, have to be introduced, though it may be that he, too, will in time, reap some harvest in the form of naturally-bred trout, progeny of the fish initially put into the water. His main problem (after having come to a decision on what he expects to catch and what he is prepared to spend in doing so) is to decide on the best method of stocking. Here, again, a critical appreciation of the particular water is desirable. Trout may be introduced at various stages from ova upwards and it will be to his advantage to use the smallest and youngest trout possible, consistent with securing the desired results.

The following chapter deals quite exhaustively with the whole question of stocking, so that the matter need not be further pursued at this stage.

Commercial development. The development of trout water as a source of income to an estate, or to the owner of suitable water, is fundamentally similar to development for private use, but is complicated by several additional factors. Here we have to consider the following:

(i) The amount of development required to produce maximum results.

(ii) Locality and type of water being of very great importance, it is essential to form an opinion as to where anglers will come from and how much they will be prepared to pay.

(iii) The most lucrative method of running the fishing, in view of all relevant factors, such as, district, type and quality of water, extent of water and type of angler likely to be attracted.

Owners within reasonable reach of large centres of population like London, Bristol, Exeter, Gloucester, Reading, Oxford, Birmingham, Coventry, Leicester, Derby, Nottingham, Leeds, Newcastle and Glasgow (to mention a few of the cities harbouring a great many fishermen) will be more fortunately placed for letting their fishing—as will those in popular holiday areas—than those within comfortable reach of fewer anglers. The locality may well dictate the type of angler to be expected and the most suitable method of letting him fish. At the same time, the type and quality of the water will play a considerable part when coming to a decision about the best way of using a stretch of fishing. It would, for example, be most unusual to find a large association fishing a mile or two of a Hampshire chalk-stream, just as the owner of a length of river in North Wales would rarely find himself in a position to let rods at a lucrative figure. In Hampshire, the rivers are usually fished by relatively few people, paying considerable sums of money for the privilege of catching small numbers of fair-sized trout; whereas, in North Wales, one is likely to find a great many anglers paying individually small amounts, but catching, collectively, large numbers of trout of small size.

The methods available to an owner for disposing of his fishing rights may be summarized as follows:

(i) Leasing to a private individual: Many waters are let to single anglers. This can be done in two ways. The tenant may either take over the fishing, together with all running expenses, or the landlord may run the fishing at his own expense, charging a proportionately larger amount to his tenant to cover the cost of keepering, stocking, maintenance and so forth. Water let privately is often of good quality, since it is bound to be a fairly expensive matter for the tenant. The item for keepering alone—for just one keeper—will amount to at least £300 per annum and the other expenses, such as rent,

rates, repairs, stocking and various smaller items, may easily bring the total cost up to £500 per annum and often much more. Waters are, of course, sometimes let privately for very much less. It may, occasionally, be possible to rent water for as little as £5 per annum, but it is unlikely to be very good fishing and for that modest rent the tenant would certainly be expected to take it as he found it and fend entirely for himself; he might catch some trout, or he might catch none.

(ii) Letting to syndicate: A water that may not attract a lone angler at a rent of, say, £100 per annum, may, nevertheless, be capable of bringing in a rent of £100 by letting to a syndicate. According to the district and type of fishing, the £100 may be subscribed by anything from 2 to 20 anglers, paying from £50 to £5 each, according to how many there are in the syndicate. Syndicates tend, in practice, to be fairly small, usually four or five anglers who are also friends. From the landlord's viewpoint, small syndicates are usually to be preferred, since they will be less obtrusive and probably catch fewer trout.

(iii) Letting to clubs or associations: Any owner of water of reasonable quality within twenty or thirty miles of a large town or city, will usually have no difficulty in finding a club or association to take it over. A fishing club may have as few as ten members, but membership of either club or association may well run into hundreds. The large clubs or associations rent water from a number of owners and are often on the look-out for fresh waters to enable them to expand their membership, or to ease the pressure of fishing on other waters. Fishing is usually on an intensive scale, subscriptions often amounting to only a few shillings per year. The more expensive clubs may charge their members anything from £25 to £250 per year, according to the district, the type of water and the quality of sport they are able to offer.

(iv) Letting to hotels : In many parts of the country, particularly in areas popular at holiday-time, hotels cater specially for fishermen. They may be owners of the fishing—perhaps the hotel has been converted from an old country house—but, more frequently, they rent water from some owner in the vicinity. Hotel water is usually fished pretty hard and sport is likely to be variable. Any hotel that can show good sport is almost certain to fill up during the fishing-season and many hotels are probably prepared to lose money on the fishing in order to keep their beds filled at night. An owner within easy reach of some well-managed and enterprising hotel may well be able to let his fishing favourably in that way.

(v) Rod-letting : The owner who takes an interest in fishing and fishery management, who is able to give the necessary time and attention to running his water, will often find that rod-letting is the most profitable method to adopt. The price at which he will be able to let rods will depend considerably on the district, reasonable proximity to a fair-sized town being desirable. To a greater extent will it depend upon the quality of sport he is able to offer. There is little doubt that an owner who keeps his water under his own control and who is prepared to develop the capacity of the fishing to the maximum, will be able to make a larger net profit than if he lets it to some organization, or individual, at an annual rent. It is, of course, reasonable that he should ; for he will have all the responsibility of satisfying his rods, together with the annual risk that some will resign and that he may not be able to fill their places.

Some hypothetical examples of how development might be carried out : The following imaginary examples are given to show what might be the most satisfactory way of deriving an income from the particular waters illustrated :

(i) A large lake, or several adjoining lakes, within 30 miles of London : The owner of such water should be in a very strong position to develop trout fishing, assuming that his water is reasonably deep and free from mud and otherwise suitable for trout.

Being within an hour's motoring distance of London, he is in a position to tap the very large demand for fishing in the London area and, if he is prepared to take a certain amount of initial risk, he may well be able to attract some of the many anglers who are prepared to pay considerable sums for trout fishing, provided the sport is good and that the arrangements as a whole are thoroughly looked after.

At the outset he has to decide whether he will cater for few anglers at high prices, or a larger number at more modest charges. In any case, rod-letting for the season is likely to be his best medium.

Stocking is undoubtedly the key to success in any enterprise of this sort. It can be taken, more or less for granted, that intensively fished waters must be stocked with trout of a size approaching whatever size-limit is imposed. It can also be assumed that growth will not be appreciable and that the vast majority of the fish put in will be caught during the same season. A few (perhaps 10 or 20 per cent) of each season's stocked fish may survive capture until the following year. The result of this is that most of the bag consists of fish averaging close to the size-limit, with a small proportion of larger fish, according to how the particular water is able to grow them on.

20—30 acres of lakes within easy reach of London should easily be capable of bringing in a gross income of £1,500 per annum at present prices. Charges for rods might vary, according to circumstances, from £50 to £100. Items of expenditure would consist mainly of the following : Keeper, or manager ; advertising ; printing rules, tickets, etc. ; provision of club-house of some kind ; stocking ; repairs ; sundries. Capital expenditure ought not to amount to more than £500 (unless a building has to be erected), most of which would go on payment of wages to the keeper and on the initial stocking. By commencing operations in October, there would be about six months wages to pay before subscriptions from rods commenced to come in. The keeper's time would be spent in getting everything ready for fishing and there would be some expenditure on repairs and in the preparation of a rod-room for members. The initial stocking might be carried out in March or April, say a month before the commencement of fishing. Assuming that the rods were fully let, all expenses should be met and most of the capital paid off during the first year.

A number of individuals have tried schemes of this sort, but few of them have succeeded. A common cause of failure is in trying to make too much profit from a fishing before it has become known and established, or through too parsimonious a stocking policy. The few who have succeeded have done so largely because they have concentrated, above all, on making the fishing as good as possible. On the basis of the above example, it will be found that about one-third of the angler's subscription is absorbed by keepering and running expenses, another third by stocking and the remainder by profit to the owner. Supposing 15 rods at £100 each, the angler should have the opportunity to catch about 100 sizeable trout, or one trout for every £1 of subscription. This is better than most of the more expensive waters seem able to offer, the cost of trout (to the angler) often working out at from £2 to £4 each and some anglers may even pay £10 or £20 for every trout they catch. The high cost of trout to the angler is usually due to inadequate stocking or to running expenses absorbing too large a proportion of his subscription. Taking this case as an example once more, it is obvious that if stocking expenditure is reduced by half, the cost of trout to the angler is likely to rise from £1 to £2. Subscriptions are often too low for satisfactory results to be obtained and often it would be better to raise subscriptions in order to raise the standard of fishing. There are still anglers about who are prepared to pay liberally for good sport. Far too many anglers are, however, likely to be asked to pay considerable amounts for very meagre baskets and they would get better value by paying rather more, assuming that the additional subscription is expended on stocking. To illustrate this point further, an owner running this particular fishing with 10 rods paying £50 each could offer them nothing at all in the way of sport, since the whole of the subscriptions would be absorbed by wages and expenses and there would be no money whatever for stocking. If he raised the subscription to £60 and spent £100 on stocking, each trout caught would cost at least £3 each. Even then the owner would make no profit and the angler's maximum annual bag would only amount to about 30 trout. It is therefore necessary to aim sufficiently high and, in my view, it is not economically possible to run a fair-sized rod-letting fishery satisfactorily on a turnover of less than £1,000 per annum, at which level reasonable sport to the angler and a small profit to the owner should result. One of the reasons for the high cost of fishing is the fact that wages take up a considerable proportion of the subscriptions. Most lakes should be managed by one man reasonably well, but it is no job for a slacker and during the fishing-season he is likely to be on the go from dawn until well after dusk.

The secrets of success in operating water for high-class rod-letting are, therefore, as follows :

(a) Looking after the fishing as carefully as possible.

(b) Provision for the convenience, comfort and sport of the rods.

(c) Stocking on a scale sufficiently high to attract anglers prepared to pay large subscriptions.

(ii) A small lake of 1—5 acres near London : This water

is probably too small for rod-letting, or to be of much interest to a large club or association. Perhaps the simplest and most profitable method of deriving an income from it would be to lease it to a single angler, or small syndicate. A small lake, with good possibilities for making trout fishing, might fetch anything from £25 to £100 per annum in this way; and the lessees would look after it and stock it with trout as they felt inclined.

(iii) A 2—4 mile stretch of south-country chalk-stream: Water of this type is always much sought after. In some cases, the subscriptions charged for rods are higher than the sport justifies. The fact is, however, that it is quite impossible to offer cheap fishing on a longish length of chalk-stream like the Test, Itchen or Kennet, since the running expenses are so heavy. Cost of keepering such a water will probably amount to at least £700 p.a. at the present time. Rates may come to a further £200, with perhaps another £200 for repairs and sundry expenses, to say nothing of stocking. Most of these waters are dependent largely on stocking for results, so that the total running expenses may easily come to £1,500 annually and, indeed, it would be difficult to operate the fishing on a much smaller sum. As already suggested, rods are sometimes asked to pay considerable sums to fish waters where the prospects of reasonable catches are anything but good, owing to the fact that most of their subscription is absorbed in paying wages and other expenses, insufficient being available for stocking. In my view, the owner of a 3-mile length of chalk-stream should aim at working up to an annual gross income of £2,000 p.a., which should leave him a reasonable margin. He may be able to get sufficient rods at £200 each, or, failing that, double the number at £100, say a maximum of 20 rods. He will have to spend at least £300 p.a. on stocking and for that expenditure he should be in a position to offer his rods satisfactory sport at a reasonable price.

(iv) A ½-mile length of chalk-stream: This water is too short to warrant a keeper, for rod-letting, or for letting to a club, though it may easily be possible to let it off to some adjoining owner wishing to increase the length of his fishery. It is fairly simple to let short lengths like this privately, the tenant agreeing to provide part-time labour to keep the weeds cut and the banks trimmed-out as he sees fit. He will also pay for any stocking that he feels to be necessary. The rent obtainable would vary, according to the quality and the demand in the area, from £10 to £100. The tenant might get his season's fishing for as little as £25, or it might cost him as much as £250, according to the sport he required and the methods he adopted.

(v) A 5-mile length of Devonshire river: The owner of this type of water, wishing to make money out of it, is probably well advised to let it off, rather than to keep it in hand and run it himself. He will probably have no difficulty in letting to some nearby fishing club, association, or hotel interested in catering for anglers. The rent obtainable might vary from £50 to £150, assuming that there are plenty of trout in the water, that it is a good breeding river and that some angling organization is near enough to be interested.

(vi) A ½-mile length of Devonshire (or west country) stream: The owner's best plan here is probably to let privately to a single enthusiast. It is too short to stand up to heavy fishing by a number of persons and probably too short to enable it to be restocked satisfactorily without much wastage of trout to adjoining lengths. Its rental value will largely be determined by the district and the particular river and might vary from £5 to £25 per annum.

(vii) A reservoir or lake near some large city, or in a holiday area: Fishing of this type is always popular. In

the case of reservoirs, the authorities usually let the fishing rights to a syndicate or association ; or manage the fishing themselves, selling season, weekly, or day-tickets to the local inhabitants, or to summer visitors. The policy, behind the development of such waters may be in either of two forms, or a combination of both. Water undertakings may seek to derive an additional income from their reservoirs, which may enable them to defray the wages of their resident caretaker or watcher, usually considered essential to keep an eye on levels, to control sluices and to be constantly on the watch for any sign of weakness or leakage in dams and embankments. If fishing is allowed, this caretaker is usually able to look after boats and examine fishing permits, in addition to his other duties. A secondary aim (or perhaps a primary one in some cases) may be, by providing good trout fishing in the vicinity, to attract visitors to the hotels during the fishing-season, thus bringing more money into the area than would otherwise be possible. Some reservoirs are well-managed ; others could do a great deal more to raise the standard of sport, which is, increasingly, becoming the measuring-rod by which anglers decide where they will go to fish. Anglers are notorious for their grouses. In my view, their grouses are often justified and, as a class, they are very long-suffering, often being asked to pay too much, for too little sport. At the same time, some anglers expect the impossible in relation to what they are prepared to pay for a certain level of sport.

Many other examples might be given, but perhaps enough has been written to make plain that the commercial development of water as trout fishing is by no means a cut-and-dried procedure and that every case must, of necessity, be considered on its merits. Briefly, the following considerations summarize the technique :

(a) Make certain that the water is fit for trout.

(b) Form an estimate of the calibre of the water in terms of growth-rate and general productivity.

(c) Determine the most profitable way of developing the water and the best use to which it can be put.

(d) Know where the fishermen are likely to be found and what they are likely to be prepared to pay.

(e) Aim at keeping the cost of trout per £1 of the angler's subscription as low as possible. Such fishing will not, necessarily, be cheap ; but the angler will get better value for money and the fishery is more likely to be a commercial success.

It does not follow, of course, that every water has a development value as trout fishing. Some waters are incapable of supporting anything but the lower forms of aquatic life. Some are so badly polluted that they can support no life at all. Others are more suitable for coarse fish, such as carp, perch, tench, roach, bream and pike, all useful and desirable in certain areas and much sought after by hundreds of thousands of anglers. In the latter case, a decision must be made as to whether coarse fish or trout are more desirable, or more suited to the particular environment. As already suggested, it is usually a mistake to try and develop trout fishing in waters heavily over-run with coarse fish.

Many anglers despair of possessing their own trout water, merely because they associate it with well-known waters they have fished or read about. Some who go miles to fish expensive waters could, if they wished, develop the streams and lakes on their own properties. The vast majority of people believe, perhaps, that the trout is a very particular fish and fussy about his environment. The truth is that trout are amazingly plastic and adaptable. Trout occasionally thrive exceedingly in waters previously written-off as hopeless. Some of the most enjoyable trout fishing and some of the largest and best-conditioned trout are caught in waters of little, if any, fame, merely through the efforts and enterprise of private individuals. Results from such waters are rarely reported. Many more small streams, ponds and lakes all over Britain could be so developed, if only their owners would open their eyes to the intrinsic worth of water capable of holding trout.

CHAPTER 6

On Stocking with Trout

THE demand for artificially-reared trout began to be met about 80 years ago, when the population of Great Britain was rather more than 20 millions less than it is at present.

Most of the commercial trout-farms in Britain are of long standing, varying between 45—80 years of age. Of about thirty-five establishments which have operated commercially at various times, more than half are now quite derelict.

Various people have thought, from time to time, that great scope for trout-culture existed in this country. The truth is that everyone who has gone in for trout-farming in Britain, investing considerable sums of money in the process, has ended his career appreciably poorer than when he started.

What are the reasons for this ? While the vast majority of anglers are insistent that there are insufficient trout in our rivers to enable sport at a reasonable level to be enjoyed, few are yet prepared to spend, individually or collectively, adequate sums of money for providing artificially-reared trout to make good the shortage caused by long years of heavy fishing. In other words, while the demand for trout is almost universal, the means to pay for them is lacking. The result of this has been that orders reaching the trout-farms have been insufficient to enable full production to be maintained for many years at a time. In the history of British trout-farming, there have been a few brief periods of comparative prosperity, as, for example, for a year or two after each of the World Wars; but, for the most part, production has been considerably in excess of the demand.

In many waters, stocking with ova, fry, or yearling trout has not been sucessful and, for years, a considerable proportion of the demand has been for fish of two or three years old, a higher percentage of which are eventually caught on the rod. Ova and fry can be produced relatively cheaply, but, unfortunately, the demand for them has enormously fallen-off and the larger, older trout are far more expensive to rear. Every £1-worth of trout sold in this country today represents about 15/- worth of food, labour, standing charges and working expenses, so that, even if the trout-farmer could be persuaded to work for nothing, trout could never be very much cheaper (relative to present-day costs) than they are at the moment. The uncomfortable truth is that raising trout is not a very economical process. Trout being carnivorous, expensive protein food—in a world starved of proteins—has almost exclusively to be used.The conversion-ratio of food into trout-flesh is not outstandingly high. This factor, alone, is a serious deterrent to the raising of trout at a price that owners and tenants of waters are able to afford, or willing to pay. If trout fishing were as essential to a man's well-being as food, drink, tobacco and a warm fireside, our trout-farms might be in a more prosperous state. The fact is, however, that trout fishing in the 20th century is something of a luxury and, as the years go by, it is likely to become even more so.

I have dwelt at some length on the economic side of the production of trout for stocking rivers and lakes. I have done so because the trout-farmer is usually, by nature, a modest self-effacing individual and seldom, if ever, gets any thanks or praise for his efforts in trying to maintain stocks of trout in this country. By now, but for the trout-farmer, trout would have been in grave danger of extinction in many parts of the country and many of those waters where sport is enjoyed today—artificial ponds, lakes, reservoirs and similar waters now holding trout—would still be fishless, or over-run with myriads of tiny coarse fish.

In the last twenty years the cost of trout has only risen by about 100 per cent. Since 1939 the increase in the cost of farm products is more than 300 per cent. and the general industrial price index has gone up by more than 200 per cent. The trout-farmer has, therefore, borne heavy burdens and made considerable sacrifices in keeping prices at unrealistically low levels. No doubt, of course, he would have raised his prices higher if the demand for trout had been so excessive that he could not meet it.

Reasons for Stocking with Trout. There are, of course, a number of reasons why owners or tenants of streams or lakes may wish to stock their waters with trout. Most of the examples given below are self-explanatory, but a few brief words of expansion may be of interest, particularly to readers with no previous experience of trout stocking.

(a) Where the native stock of trout is becoming scarce : It is common experience for an owner of trout fishing to come to the conclusion that there are fewer trout in his water than there used to be. Possibly he is in the position of being able to look back many years to the time when the water was owned by his father, or grandfather, and is able to recall that sport was much better in the past. He may have records to back the accuracy of his memory ; for memories in relation to fishing are not too trustworthy, most anglers believing, rightly or wrongly, that fishing was infinitely better in the days of their youth. In many cases, however, there is no doubt about the dwindling stocks of wild trout. This may have been caused by a combination of circumstances, such as pollution in various forms. abstraction of water, increase in vermin, lack of keepering, poaching, over-fishing, etc. Assuming no permanent damage to the water, the owner is often in a position to retrieve the situation by the introduction of artificially-bred trout of a type and size likely to adapt themselves to the particular environment.

(b) The wish to introduce trout to a water for the first time : Trout are by no means indigenous in every water likely to suit them. Many keen anglers, finding themselves in possession of water, are interested in the possibility of putting in trout. Most of them seek advice as to the probable success or failure of stocking such waters and, though some waters are not suitable for trout, trout have been successfully introduced in a large number of cases.

(c) For re-introducing trout to a pond or stream : Ponds and the upper reaches of many streams are liable to occasional drying-up. When this happens, the whole of the existing stock of trout is usually lost. Sometimes an accidental pollution will wipe out the whole stock. Occasionally pike will get the upper hand and all the trout will disappear. The collapse of a dam, or lowering of a stream for repairs to sluices, may make conditions temporarily impossible for trout. Most owners of such water are naturally anxious to re-introduce trout as soon as the particular cause of the disaster has been removed.

(d) For stocking an artificial pond, lake or reservoir : Hundreds of artificial waters, suitable for stocking with trout, exist all over the country. Occasionally new ones are made. Most Water Undertakings now recognize the value of trout fishing and are usually interested in keeping their reservoirs adequately stocked. Large numbers of country houses have lakes or ponds of various sizes within a stone's throw and, sooner or later, the owner comes to the conclusion that if trout could successfully be introduced, the amenities of his property would be materially improved thereby. Unfortunately, most of these ponds and lakes date back at least to the second half of the 19th century and many have silted-up with mud or become choked with rushes. Dredging is sometimes too costly to contemplate. Those remaining in reasonably good con-

dition are, however, often stocked with trout with excellent results.

(e) To enable a greater intensity of fishing per unit area or length: Where fishing is already enjoyed, it commonly happens that more anglers wish to fish the water than can be justified by the stock of wild trout already present. By judicious stocking, clubs, syndicates, hotels and others interested in angling, are able to provide sport for more anglers than would otherwise be possible.

(f) To increase the size of trout in the water: Heavily-fished waters—though often of high potential productivity—are frequently unable to grow enough trout of a satisfactory size. Trout grow rather slowly in the majority of waters, and are liable to be caught sooner, rather than later. By stocking with a larger size of trout, this difficulty can, to some extent, be overcome.

(g) To change the type or strain of trout: The native strain of trout in many waters is of poor quality. Heavy fishing during several generations has resulted in the largest and fastest-growing fish being caught every year, the smaller, slower-growing trout remaining in the water to breed. In the course of time, the size of the trout becomes progressively less. Stocking with a well-bred strain of artificially-reared trout can sometimes effect a great improvement, though such introductions of fast-growing fish should be kept up regularly over a period of years. It should be remembered that, while in a state of nature (assuming that fishing is taking place) the best fish are killed and the worst remain to breed, the trout-farmer makes a practice of making annual selections of his very best fish for breeding purposes.

(h) To introduce a freer-rising strain: Anglers often complain that trout in a particular water do not rise to the fly sufficiently well. The free-risers tend to be caught and,

after many seasons fishing, the local strain may acquire non-rising characteristics. Excessive bottom feed (though extremely desirable if really large trout are to be expected) may, at the same time, tend to make trout feed less at the surface than anglers would wish. Trout from trout-farms tend, if anything, to rise almost too freely and, for some time after being turned out, can usually be caught on a dry-fly rather too easily. All through their life in captivity they have looked upwards for their food. Their food is given to them at the surface and it is natural for them to maintain this characteristic, provided adequate surface food is available. Eventually, they have to adjust themselves to the particular environmental conditions as regards food, but, unless non-rising is due to a dearth of fly, the introduction of hatchery stock will almost certainly prove to be beneficial.

(i) To enable rods to be let on a commercial basis: In a book published in 1938 the author wrote: "The more a man wants to make from his fishery—and many are smitten in these days with the idea of making an easy income in this way—the more he will have to stock. If he cuts down on stocking his rods will soon desert him. The more rods he has, the more he will have to stock; and, within limits, the more he stocks, the more rods he can reasonably let. It is a mistaken idea that a few pounds spent on stocking entitle a man to let his rods for what he likes. Fishermen may be deceived for a season or two on a likely-looking stretch of water. But when they find they have been deluded, they will not come back."

If this was true in 1938, it is even more true today. Stocking is the key to success in attracting anglers at worth-while rates. It is, however, only fair to point out that much has happened since 1938 to make the running of fishing on a commercial basis considerably less profitable than formerly. Costs of every kind have risen steeply. Keepering costs have risen by something like 300 per cent., rates by 50 per cent. or more, materials of all kinds by from 200—300 per cent., stocking by about 100 per cent. On the other hand, the amount that anglers pay for their fishing has risen very little and, in some cases, not at all. It is doubtful whether the average rise in the cost of rods exceeds 25 per cent. with a maximum rise of 50 per cent. in rare instances. This means that there is less profit to be made by owning fishing, unless additional rods can be taken on to help make up some of the deficit.

Even so, a water heavily stocked with trout will usually attract anglers prepared to pay infinitely more than would otherwise be the case.

The purpose for which fishing is to be used. In any scheme for stocking, or re-stocking, a water with trout, it is always of prime importance to have a clear idea of the objectives in view. The pattern of the stocking programme will vary (or should vary) according to the particular objective in mind. The examples, given above, illustrate the type of motive that may impel an owner of water to stock it with trout. Other points to be borne in mind include the following:

(i) What level of sport is required?

(ii) How many people are expected to fish the water?

(iii) How long are trout to be given to grow before fishing will commence?

(iv) How much money is available for stocking purposes?

Quite obviously, the answers to the above questions will have a profound influence on the stocking policy to be adopted. The desire to capture large numbers of heavy trout will be a more difficult and costly objective than satisfaction with a few trout of moderate size. One man, fishing on his own water alone, will need fewer trout to keep him happy than when many anglers are expecting to fish. The period elapsing before fishing commences may considerably influence the size and, to a lesser extent, the number of trout required. The money available for the purchase of trout is often, but not always, a limiting factor.

Quality of Water. The quality of a particular water—its length, depth, area, physical and chemical characteristics and many other factors—will play an important part in forming an opinion about the best way to stock it with trout. These factors have been dealt with in a previous chapter ; but it is of great importance to recognize that no two waters are exactly alike and that what has worked wonders in one water will not, necessarily, be anything of a success in another. Growth-rate, maximum size attainable, facilities for reproduction, the presence or absence of enemies and competitors, composition of the aquatic flora and fauna, will vary so markedly from place to place, that even experts, with long experience of these problems, are rarely prepared to predict, with any considerable degree of emphasis, just how things will turn out. While the higher the natural quality of a water, the better is stocking, to any pattern, likely to succeed, it is, nevertheless, often possible to achieve remarkable results in a less favourable situation by skilful appreciation of all its qualities, good and bad, and planning the stocking programme so as to make use of the good qualities and to offset the less attractive ones.

Number of trout to area or length. It is almost impossible to generalize in the matter of how many trout should be put into an acre of lake, or a mile of river. So many factors have to be considered that it is necessary, first, to have all available information, including, especially, an accurate conception of the nature of the fishing contemplated. What would be adequate for a private length of chalk-stream fished but lightly by the owner and a few of his friends, might be quite useless in the case of the same piece of water heavily fished by syndicate or club.

Here again, the natural quality of the water comes very much into the picture. Some waters will grow up to 100 lbs. of trout to the acre per annum ; others will not produce an increment of 5 lbs. of trout to the acre. Yet, it is possible, in the vast majority of cases, to provide good sport in either situation by an appropriate stocking technique, based primarily on the following questions :

(i) What is expected in the way of sport ?

(ii) What money is available ?

(iii) What number and—more important—what size of trout will best enable the target to be reached ?

When to stock ? Something like 75 per cent of all trout-stocking projects in Britain are carried through in the spring, during the months of March, April and May. Some waters are stocked in September or October and a few waters may be stocked more than once during the year. Streams and rivers are usually stocked during the spring, though there may sometimes be an advantage in turning out fish during the autumn, particularly where trout can be relied upon to remain close at hand or to return during the fishing-season. Lakes may often be stocked advantageously in the autumn, especially those with no inlet or outlet, or those on the headwaters of small streams. The main advantage of autumn stocking is that trout are better value then than in the spring. An autumn 'yearling' of 3-inches is equal in every way to a spring 'yearling' of 6-inches ; in fact 3-inch trout offered in the autumn will be exactly the same fish as 6-inch in the spring. This truth is insufficiently realized, the more surprisingly since the cost of 3-inch yearlings is about 55 per cent. cheaper than 6-inch. Similarly, a 12-inch trout in the spring costs about 50 per cent. more than a 10-inch trout in the autumn and is, under average conditions, the identical fish. If, therefore, the environment is favourable to autumn stocking, there is a direct financial inducement on the part of the purchaser to take delivery of his trout at that time of year. Fishing-clubs or rod-letting fisheries, which are usually buyers of two-year-old or three-year-old trout, ranging in size from 10 to 15-inches, frequently take delivery shortly before the fishing-season opens. In that way, a higher percentage can be expected to be caught than if the trout have been turned into the water months beforehand, when losses due to predators and to migration up or downstream are apt to take a toll to an appreciable extent.

As in other directions, however, the best time for stocking should always be considered in conjunction with all other relevant factors and it would be quite impossible to lay down hard-and-fast rules to suit waters even closely similar in character.

Periodical stocking is sometimes carried out, usually on heavily-fished club waters. There is a tendency, where sizable trout are turned into the water just before the fishing season commences, for rods to catch a great many trout for the first few weeks of the season, after which the quality of sport deteriorates. Where fair-sized trout are liberated to the extent of several thousands annually and where the bag is also counted by the thousand, it is sometimes found to be a good plan to stock in two or more stages each season. In this way, the quality of sport tends to be evened out and the heavy slaughter of fish usually occurring early in the year is appreciably diminished.

The merits of different ages and size of trout for stocking:

(i) Ova: Trout commence life as an ovum or egg. In trout hatcheries, the ova are stripped from the fish artificially and laid down on special grills, or trays, in hatching boxes, through which there is an adequate flow of water, suitable in quality and within a temperature-range of 35—55 degrees F.

The earliest possible time at which trout ova could be distributed for stocking purposes would be in the 'green' stage, within 12 hours of fertilization. In practice this method is seldom adopted. Once segmentation of the ovum commences, the eggs become tender and it is then unsafe to remove them from the trays until they are about 70 per cent. incubated, a period that will vary according to the temperature of the hatchery water-supply. Where the hatchery water temperature averages 50 degrees F., this stage will be reached at about the 35th day of fertilization. At an average temperature of 40 degrees F., the 'tender' stage will last until about the 85th day. Ova are, therefore, sent out when reaching this fairly advanced stage of incubation, at which time the 'eyes' of the fish are plainly visible through the envelope. Any dead or weakly ova will have been picked out by the hatchery attendants before this stage is reached, so that from well-run hatcheries only perfectly sound ova are dispatched.

The chief sales of ova are to other fish farms, government fishery departments overseas and to fishing-clubs or other owners of small hatcheries. At one time, there used to be a demand for eyed ova in many parts of the country for 'sowing' into the gravel of shallow streams and rivers, with the idea of augmenting the natural breeding of native stocks of trout. This practice has now entirely died-out. Some of the most effective introductions of trout to virgin waters abroad were (and still are) done in this way.

It is almost certain that success would follow from careful sowing of ova in any virgin water of suitable quality; but where trout are already present, little improvement is to be anticipated.

While eyed-ova may be expected to hatch-off quite satisfactorily, the resulting alevins are immediately the prey of almost everything that swims, or flies, or runs. There is the added, and, uncommonly recognized, fact that where trout are already present, the number of naturally-laid ova will far exceed any probable artificial releases and, therefore, such artificial releases cannot hope to play an appreciable part in increases to the stock. If ova were to be liberated on a far larger scale the answer might be quite different; but releases would need to be by the million rather than by the thousand. Small releases of ova in waters already containing trout are, in my view, of slight use and the money could be spent more advantageously in some other way.

Fry: After hatching, the young trout is a helpless creature, hampered greatly by the large yolk-sac (umbilical sac) slung from the region of its belly, upon the contents of which it subsists for several weeks or months, and during which period it huddles under gravel and stones as much away from the light as possible. After about 4—10 weeks—the colder the water, the longer the period of absorbtion—the sac is completely absorbed, the little fish assumes a swimming position and begins to snap at any small fragments floating past in the current. The success, or failure, of fry in keeping themselves alive is determined, largely, by the ease with which they are able to obtain the necessary amount of food and, also, whether they happen to come within the range of vision of one of their numerous natural enemies. Where food of the right kind (microscopic zoo-plankton, immature shrimps, larvae, etc.) in adequate quantity is available and, where enemies are scarce or absent, fry, at almost any stage, may be expected to survive in large numbers. Unfortunately, in not one case in a hundred, do such conditions obtain. Accordingly, the vast majority of the fry perish. In those few cases where fry have had a reasonable chance, results have sometimes been amazingly successful. Examples of such successes would include instances of re-stocking streams which had dried-up; small streams not previously holding trout; ponds, lakes and reservoirs stocked with fry shortly after completion and before any other fish had got in.

In waters already holding trout, the most likely use to be made of fry is, either in extremely heavy stockings with 'ready-to-feed' fry, or in somewhat lighter stockings of more advanced fry. It is to be remembered that every minute, of every hour, of the day and night, is filled with danger for every trout fry, in ninety-nine waters out of a hundred. Wide distribution of fry is undoubtedly of considerable importance, since this may effect an improvement of the odds in favour of survival. As the fry get older in the water in which they have been distributed, their ranks are liable to a deplorable thinning-out. But the percentage rate of wastage becomes progressively less, since they are scattered more widely than at first, less plentiful and less helpless.

A fishery owner anxious to stock with fry must, therefore, decide whether it would be more profitable to put in unfed fry on a large scale, or whether to stock one, two, three or four months later, with older fry on a reduced scale, but which would cost him considerably more per 1,000. For example, 50,000 unfed fry might cost about £100, whereas £100 would only buy about 15,000 three-months fed fry. The decision as to which would be the more economical in the long-run would depend on the fate anticipated for the 50,000 unfed fry, during the 90-odd days they would be in the water, before reaching the three-months stage. It is worth noting that a loss of only 1 per cent. per day over that period would bring the number down to little more than 20,000 ; that is a 60 per cent. loss in 90 days. The bulk of these losses would not be due to starvation, but to the action of predators. Fry are, therefore, only likely to be successful in waters comparatively free from potential enemies. Older trout are, perhaps, their most effective decimator. Small-scale stocking with fry is likely to be effective only in virgin waters and those as free from all other fish as possible.

Yearlings: The period of life, during which trout are known as 'yearlings', is somewhat flexible. Their actual birthday may be from early November to the middle of January according to the spawning-date of their parents a year previously. In practice, they are classed as 'yearlings' from September until the following summer. As already suggested, an autumn yearling of 3-inches is equal in quality to a 6-inch spring 'yearling'. Some trout-farms still sell yearlings 'as they come', that is, ungraded fish ranging in size from 2—5 inches in length. More often they are listed at definite sizes, e.g., 2-inch, 3-inch, 4-inch, 5-inch, 6-inch. In the autumn, the only sizes likely to be available will be 2, 3 and 4-inches, whereas in the spring all sizes from 2 to 7-inches may be listed. It is only fair to point out to potential purchasers of small spring yearlings, that by going for what they believe to be cheap fish they are, in fact, getting the cheapest in every way, the 2-inch fish being the slowest growers and the poorest 'doers'. Anyone wishing to buy small 'yearlings' should, therefore, in his own interests, seriously consider the possibility of taking delivery in the autumn, when a two-inch fish, for example, is a very nice little trout. If purchasing in the spring, the larger sizes are the better growers and likely to make into bigger trout in the long-run.

In the above paragraph, I would stress that I am comparing the quality of various sizes of yearlings from the same trout-farm and from the same strain. It is not possible to compare yearlings of similar size from two different sources with any certainty that one will be better than the other. A yearling at one establishment may be small, by virtue of the fact that it is the smallest size in its batch. At another establishment (for example, one with a lower water temperature) a similar-sized yearling may be an excellent representative from its particular batch. Though of similar size and identical in appearance, the first may have inherited a tendency towards smallness, whereas the second may have inherited characteristics in the direction of largeness and, if so, the second is likely to be the better fish of the two.

A safe rule in buying yearlings from any trout-farm is, therefore, to go for the largest available at time of delivery. Naturally it would be most awkward for a trout-farmer if only his largest yearlings were sold. By skilful advice to his customers, however, it should be possible to sell good 'yearlings', for their age, during any part of the season.

Are yearlings good value from a stocking point of view? The accurate answer to that is that sometimes they are ; sometimes they are not. It all depends on the particular water and the way that water is used for fishing.

Yearlings are likely to die from natural causes only to a very limited extent. They are less vulnerable than fry to many enemies of trout, more so to others. For example, the kingfisher is more interested in trout fry than yearlings ; the heron more interested in yearlings than fry. Many of the very young trout's enemies (e.g., beetles, bullheads, sticklebacks, dabchicks, etc.) are incapable of assaulting a yearling. That gives to the yearling a very real advantage and, accordingly, where large predators are absent, or scarce, yearlings are likely to do very well. In waters where there are large trout, pike, large perch and herons, the yearling is likely to find himself in a continual state of anxiety about the future. In the latter class of water—quite numerous—to stock successfully with yearlings is likely to involve turning in a much larger number per mile, or per acre, than in the former, where enemies of yearlings are relatively scarce. The alternative is to skip a year and stock with two-year-olds, or larger, fish, the merits of which are dealt with in the appropriate section below.

A yearling (and more so, a fry) has got to live a considerable time—certainly two and probably three or four years—before being fit to catch. He is much more likely to attain that age in a water where vermin are few. In spite of his vulnerability, the yearling is, however, often of very great value for stocking purposes, particularly in those waters where those who fish are able, or willing to wait a few years to give them time to grow. Small rain-fed streams, the upper reaches of chalk-streams, ponds, lakes and reservoirs are all potentially suitable for stocking with yearlings. Ponds, lakes and reservoirs, at present fishless, or which have been drained and cleared of coarse fish, are almost certain to give good results if stocked with yearlings, though older fish will certainly do equally well. Heavily-fished club and association waters do not always lend themselves well to yearling stocking, the small fish being a nuisance to anglers and, being hooked and returned in considerable numbers, are liable to injury or worse.

Stocking with yearlings on short lengths of river is also rather a risky matter. By the time they are ready to catch—in two or three years—many are almost certain to have migrated up or downstream. That is an argument in favour of owners of fishing on a river combining in their stocking operations. This, however, is a counsel of perfection and unlikely to be realized, owing to the variation in quality in any river, up and down its length, and to the differences in opinions, keenness and objectives of the various owners concerned.

Two-Year-Olds: What has been written about the yearling can, to a considerable extent, also be applied to the two-year-old. The enemies of ova and fry cannot assail the two-year-old, but the two-year-old is little better off than the yearling in his degree of vulnerability to pike or herons. The chief advantage of the two-year-old is that he is one year nearer to potential capture on the rod and therefore, there is one year's less risk of loss from predators. There is also one year less for him to roam abcut and get into neighbouring water, where he will doubtless be much appreciated, but where he will be of no value to his purchaser.

A southern trout-farm, where growth is faster than in the north, due to the higher mean annual temperature, may list two-year-olds from 7 to 13 inches in length.

What was written about autumn and spring yearlings can equally well be written about autumn and spring two-year-olds. A 7-inch autumn two-year-old is equivalent to about a 9-inch spring two-year-old and a 10-inch autumn two-year-old is in the same class as a 12-inch spring two-year-old. Here again, therefore, it is well worth while for the purchaser to understand what he is buying and, if he prefers small two-year-olds—which are much cheaper—to arrange, assuming his water to be suitable, to take delivery in the autumn rather than in the spring.

Some trout-farmers might prefer, perhaps, not to stress this point, but it is, nevertheless, of considerable importance to the buyer. In brief, what would be considered a well-grown fish in the autumn, might rank as a 'runt' in the spring.

Two-year-olds are very popular with purchasers of trout. A great many fishing-clubs, particularly in the midlands and north country, are purchasers of two-year-olds and find that they cannot keep going satisfactorily with anything smaller. Many private owners also favour the two-year-old as being a compromise between the yearling and something larger.

Large two-year-olds and three-year-olds: The best fish offered by trout-farms, favourably situated as regards pond-space and water-supply, will usually vary from 12 to 16 inches, ranging in weight from about ¾-lb. to 1¾-lbs.

In the past, some writers on trout fishing have gone considerably out of their way to poke fun at these fish. They have said that such trout rapidly lose condition, quickly disappear, or turn sulky. It is quite true that, on occasion, they may do any of these things, but, taking things all round and, particularly, in the light of fishing conditions in Britain today, these well-grown fish give considerable satisfaction. In fact, it is absolutely certain that many of the best-known fishing-clubs and rod-letting fisheries as far north as Yorkshire, would have the greatest difficulty in carrying on at all without the 'ready-made' trout. The ready-made, or sizable, trout for stocking heavily-fished waters, has become extremely popular and it is most unlikely that this popularity will grow any less. It is, of course, quite true that one of the main drawbacks to these sizable fish is their cost. It is equally untrue to suggest that the trout-farmer deliberately tries to boost the sale of these fish simply because they are expensive. Actually, the trout-farmer would much prefer to sell smaller trout. Although cheaper per fish, he gets considerably more for them per pound weight and it would be much more profitable for him if he could turn over the same amount of money in fry, yearlings and small two-year-olds as in the larger sizes. For example, the present price per pound of trout at various stages of growth, compares as follows :

Three-months fed Fry ...	160/-	per pound
3-inch Yearlings	59/-	per pound
8-inch Two-year-olds ...	12/6d.	per pound
12-inch Two-year-olds ...	11/2d.	per pound

From the above figures, it should be abundantly clear that the more small trout the trout-farmer can sell, the more profitable it will be for him. As, however, the demand tends more and more towards larger fish, he has no choice but to try and meet that demand and, in meeting it, has a much slower turnover on his stock, vastly greater food-bills and a greatly depreciated price per pound on every trout he sells.

In brief, the large two-year-old or three-year-old has established himself highly in favour, for the very practical reason that he has proved himself to be an efficient means of stocking the vast majority of heavily-fished waters, particularly in the southern half of England. There is less risk of such a fish doing anything untoward. Before he has time to decide that he would like to wander away somewhere else, to lose condition, or to be swallowed by a pike or heron, some angler comes along and hooks him. A large percentage of these trout are, in fact, hooked and caught. That is the major reason why people buy them. If risks and attendant losses were less in the case of smaller fish, a higher percentage of them would eventually be caught and more people, in consequence, would buy small trout. The large two-year-old and three-year-old have only become the favourite after long years of trial and disappointment with smaller sizes.

Large Trout : Few trout-farmers go out of their way to supply large trout except in small quantities. There is, however, an intermittent demand for trout ranging in size from 2 to 6 lbs. Most of the purchasers of these large fish are either clubs or rod-letting fisheries. The purpose of having them is to try and break the monotony of catching trout too level in size and to give members a sporting chance of a really big trout occasionally. It is doubtful whether many of these big fish, which are usually from 4 to 6 years of age, ever really settle down. This, however, is unimportant, since most of them are caught during the best weeks of the fishing season, usually on the mayfly. Those who buy them—no one buys big trout exclusively—usually come back for more in subsequent seasons, so, presumably, they give a considerable amount of satisfaction. A 4-pounder may seem expensive at 30/-, though actually the S.P. may well be less than the cost of production. The trout-farmer is, however, glad to sell big trout at all ; if he kept them indefinitely they would cost him a fortune in food—the current cost of feeding a 4-lb. trout for a year is about 18/6d.—and need far more pond-space than could be spared. As he has, no doubt, taken a considerable number of ova from these big fish in previous seasons, he is quite prepared to let the fish themselves sell at what they will fetch.

Rainbow Trout : Much has been written during the last fifty years about the virtues and deviations of the Rainbow Trout. In his native waters—the Pacific slope rivers of North America—there appears to be no complaint about his behaviour. Presumably, in fact, it was simply because of his size and game qualities that the desire to introduce the rainbow to other parts of the world became acute. Successful introductions followed in a number of countries ; but there were also many failures. I do not propose to drag-up all the old arguments as to why the rainbow trout cannot freely be acclimatized in Britain ; nor to say much about his common feat of mysteriously vanishing without trace. All this can be found in numerous books and old copies of angling journals. Whereever anglers foregather, the conversation, sooner or later, will turn to the subject of the rainbow. All sorts of remarkable theories will be discussed, supported usually only by the creator of any particular theory.

I would like to make the following points, however. The rainbow does not like cold water and is capable of standing a slightly higher temperature than brown trout. He is a very voracious feeder and, unless food is very plentiful, is, for that reason alone, likely to get the urge to wander. Given the necessary amount of food, his size in three years will be double that of brown trout, though he will consume double the amount of food in the process. To my mind, however, the most interesting thing about the rainbow trout is that, compared with the brown trout, his average span of life is considerably less. Few rainbows live longer than six or seven years. The best years of a rainbow's life are, usually, his third and fourth, at the end of which he can easily reach a weight of 7 or 8 lbs. in Britain. In Australia, rainbows have exceeded 15 lbs. in weight at the age of just over 3 years. The rainbow is, therefore, a short-lived fish. Other observers may have noticed this, but I can find no record that any particular attention has been paid to the fact that rainbows tend to die young, living little more than half the natural life-span of a brown trout.

This fact alone may, perhaps, go a considerable way towards explaining why rainbows are rarely a permanent success. Rainbows are normally offered for sale as yearlings or two-year-olds. Experience has often shown that if they are not caught during their third or fourth year of life they are rarely caught at all. In brief, many of the rainbow's so-called vanishing acts are, nothing more, but nothing less, than loss by attaining their natural span of life.

Those who wish to introduce rainbows to waters likely to provide temporary sport with them are urged, therefore, to buy well-grown yearlings or two-year-olds and to fish them as hard as possible when they are 3—4 years old. A considerable percentage may then be caught. Rainbows of 1½—3 lbs. during their third summer give wonderful sport.

Which waters are suitable for rainbows ? Provided the water is not too cold and that the feeding is good, almost any water suitable for brown trout will also hold rainbows. The chances of permanent acclimatization are, however, remote and I know of only three streams in the south of England where rainbows have, to a limited extent, succeeded in reproducing themselves at all. Few owners turn rainbows into rivers, owing to their propensity to wander. Good sport is often had with them in ponds, lakes and gravel-pits.

One other note of warning about rainbows. In some parts of the country they are liable to be attacked by parasites. Certain parasites, common among coarse fish, will also attach themselves to rainbows. In this connection, I can recall, quite recently, two failures in stocking lakes with rainbows, both of which contained many coarse fish. This disease is popularly known as 'white spot' and the fish get smothered in whitish pimples and rapidly get thin and die. Another serious disease is caused by rainbows eating snails infected with the larvae of parasitic worms from wildfowl. Any water visited by large numbers of sea-gulls, ducks, and, probably, coots and moorhens, is liable to carry infected snails. The larval parasite works from the stomach of the fish into the lens of the eye and quickly causes total blindness. I have had personal experience of two serious cases of this, nearly every fish examined being totally blind, the only remedy being to destroy the whole stock. For this reason, it is now usual to give a word of caution about infective risk and we prefer not to send rainbows to waters heavily infested with coarse fish, or over-run with wildfowl and gulls.

Planning a water's stocking programme : The information given in the foregoing part of this chapter should be of some little help in planning the stocking programme of any water. To summarize, the most important factors to bear in mind are, I believe, the following :

(i) To have a good reason for stocking.

(ii) To aim at a definite objective in the matter of results.

(iii) To realize that the pattern of stocking can be very flexible and is largely governed by the objectives in view.

(iv) To have an understanding of the natural potentiality and limitations of the water concerned.

Advice on stocking. Anyone in doubt or difficulty can always go to a trout-farmer for advice. While he will not refuse to sell you trout if you order fish without consulting him—and who should blame him—if you care to ask his advice and tell him all the facts, he will, at least, give you the value of his experience, though he will rarely go so far as to predict results, except in very round figures. You may rest assured, however, that having been consulted, the trout-farmer will take the best possible care in his interests as well as yours, that nothing is done that does not have a reasonable chance of some success. If a water appears to be quite hopeless for trout, he may be relied upon to tell you so point-blank.

The preparation of a water for stocking. A gardener would not dream of taking delivery of fruit trees, or rose bushes, without first giving considerable attention to the ground in which he proposed to plant them. The domestic poultry-keeper, with a few dozen day-old chicks on order, makes sure that the coop is warm, dry and rat-proof and that he is in a position to provide the chicks with the right kind of food when they arrive.

It is surprising, therefore, that trout-stocking is often rather irresponsibly carried out, sometimes nothing at all being done to insure that the trout have a reasonable chance of surviving and thriving.

What form should preparations take ? Needless to say, much will depend upon the type of water concerned, Some waters will need little in the way of preliminary work ; others may need a great deal. The object of any precautions will mostly be covered by the following :

(i) To insure that the water is as attractive as possible to the trout.

(ii) To insure an adequate food-supply.

(iii) To take any steps likely to prevent trout from migrating up or downstream.

(iv) To reduce vermin to a minimum *before* the trout are turned in.

Here again, much will depend upon the type of water. A stream will, obviously, be a very different proposition than, say, a lake with no inlet or outlet. Thin, shallow water can be made more attractive to trout, by breaking it up by means of simple dams of timber or concrete bags. Trees and bushes, growing too thickly, can be carefully thinned out, leaving plenty of cover and shade, but making fishing possible in difficult places and, at the same time, letting in more light, the absence of which will retard the growth of weed and food. Steps can be taken to plant up weedless areas and useless weeds can be cut out.

Anything that can be done to improve the food-supply is bound to be of value. If there are gratings or screens on a stream, or at the inlets and outlets of ponds and lakes, make sure that they are safe for the particular size of trout to be introduced. By dividing the length of a trout by 12, it is possible to estimate the mesh that will be safe. For example, supposing a grating with 1-inch spaces between its bars to be in use, the smallest size of trout that could be held in perfect safety would be in 12-inches in length. The wider the space between bars of a grating, consistent with retaining the fish, the better. Less work in keeping the grating free from rubbish will be involved. Make sure that the footings and housings of gratings are not under-cut or washed-out. There may be a perfect grating in position, but it will be quite useless if there is any way underneath, or round the sides. Where gratings are to be used, provision must be made for cleaning them regularly. In the autumn, for example, most gratings will block completely with fallen leaves in a few hours. Once the water starts going over the top, trout are certain to jump it ; in fact it is an invitation to them to do so.

Make sure, before the trout arrive, that the water is as clear from vermin as possible. This may not be easy. To put yearlings, for instance, into a water swarming with pike is almost certain to result in nothing more than a welcome feed for the pike at your expense. The water should, therefore, be netted or electrically fished before the trout go in : not six months afterwards, by which time the damage will have been done. Pike are only one of dozens of creatures likely to attack trout at various times and in various situations. Careful watch should be kept for signs of any insect, fish, bird, or animal likely to have a significant effect on the trouts' chances of survival. For example, a water, teeming with small perch, bullheads, or water beetles, can easily cause the complete failure of even a large-scale fry stocking ; an otter, or heron, constantly visiting a small pond, or stream, to be stocked with a few hundred two-year-olds, is quite capable of clearing out the lot in the space of a few weeks. A preliminary war on all kinds of predator can, therefore, make all the difference between having some enjoyable trout-fishing in twelve months' time, or having no trout at all. There is no doubt that, in most cases where stocking is proposed, the more careful the preparatory work, the more successful will be the result.

The Transportation of Trout. Having done everything possible—within the limits of commonsense, economy and feasibility—to insure that the trout you have ordered will find your water as attractive as possible, that there is enough for them to eat, that escape is made as difficult as possible and that they will be preyed upon to the minimum, arrangements for delivery can be made.

The first thing to decide is the method of delivery. It is usual to choose the cheapest and safest means of transferring the trout from the trout-farm to their new environment. Three methods are widely adopted :

(i) *Collection by the purchaser from the trout-farm :* Even a private car is capable of collecting several thousand trout fry and up to 100 yearlings in suitable containers.

A 10-cwt van can take 20—30,000 fry, several hundred yearlings, or up to 100 good two-year-olds. Suitable containers can be borrowed from the trout-farm. These usually weigh about 1½ cwt. when filled with water and hold about 7 lbs. weight of trout over a considerable distance, provided the weather is reasonably cool and that stops on the journey are kept down to the minimum.

(ii) *Passenger train :* Where there is a fairly good train service, trout can be sent over long distances in 1½ cwt. containers. Usually it is inadvisable to use the rail between May and September, owing to the risk of the water overheating. Connections must be good and waits as short as possible. All arrangements are worked out by the trout-farm in conjunction with the railway authorities. The consignment goes through to an exact time-table and the purchaser meets the train on arrival at his home station with suitable transport for conveying the containers to the waterside. Costs on the railways are, unfortunately, now very high and except for very small consignments, it is usually cheaper to take delivery by road.

(iii) *Road delivery* : All trout-farms now operate one or more lorries, equipped with special tanks, fitted with an auxiliary oxygen-supply, for delivering trout direct to the stream or lake concerned. Part of the cost of this service is paid by the purchaser of the trout : at present about 1/- per mile both ways. This is usually much cheaper than the cost of sending by rail and there is also the saving on transport at the other end. In addition, the lorry is usually able to get within a short distance of the water and, in many cases, goes cross-country through water-meadows, along field-tracks and, anywhere, in fact, smooth enough and dry enough to permit the vehicle to get along without getting bogged. This is a great advantage and saves a tremendous amount of time and trouble in distributing the trout.

Delivery dates are arranged at least a week in advance, sometimes months in advance. The minimum notice required would be about 48 hours. During the spring, most dates are filled up for weeks ahead and it would rarely be possible to make the necessary arrangements in much less than a week.

A rendezvous and estimated time of arrival are also mutually agreed. Trout-farmers pride themselves on the smoothness and punctuality of their delivery arrangements and when they write and say that their vehicle will be at a certain spot at a certain time, it is as certain as anything can be, in view of existing road and traffic conditions, that it will be there on time, or perhaps a little sooner.

The purchaser will be at the rendezvous at the same time, with any necessary helpers. The trout-farmer will usually have indicated what will be needed in the way of help. If it is a large consignment, three or four men will be an advantage. Usually one or two are sufficient. The driver will always unload the trout-tanks and help with carrying and distribution, but he will always need at least one helper.

At places where the ground is too soft, or otherwise impassable by a lorry heavily loaded with fish-tanks, other means have to be adopted. If not too far, the baths can be carried by hand, sometimes many trips being made from lorry to waterside. Occasionally, it is helpful to borrow a farm-cart or tractor-and-trailer. This sort of assistance should be ready by the time the lorry arrives, so as not to cause more delay than necessary.

As soon as the lorry arrives at the rendezvous, or has proceeded from there to the nearest point from which the water can conveniently be reached, distribution of the trout can commence at once.

Distribution of Trout. Once again, the particular type and nature of the water being stocked will determine the methods used for distributing the trout. The number and size of the trout in the particular consignment will also be taken into consideration.

In the case of a pond, or small lake, being stocked with yearlings or larger fish, there is little to be gained by not putting the fish all in at one point. They will rapidly spread out and distribute themselves. Naturally the most convenient place is selected, where the fish can be got safely into deep water without having to work their way through mud or dense belts of rushes.

When stocking a pond, or lake, with fry, it is usual to spread widely, either round the edges, or by going out in a boat. Unsuitable spots for fry should be avoided. The chances are that spreading fry as thinly as possible will minimize losses from vermin and enable the most to be made of the available food supply.

When stocking streams or rivers, it is common practice to spread trout more or less evenly along the more accessible portions of the whole stretch. Five hundred yearlings would, for instance, probably be put in at various points in lots of fifty or 100 fish. Larger fish are usually put out in lots of twenty-five, or even less in the case of very big fish. In stream and river distribution, consideration has to be given as to whether the trout are most likely to run up or drop back. As, in my experience, they nearly always run upstream—the faster the water, the more are they likely to push up, at any rate for a time—it is often prudent to introduce the fish towards the lower end of the particular beat. Ideally, a stream should have some sort of obstruction at either end. Weirs and mills form excellent, though by no means impregnable, barriers to the passage of trout, in either an upstream or downstream direction. Where there are no obstructions at all, reliance has to be placed on the water being sufficiently atttractive to retain them. A stream with bends and deep holes is more likely to hold the trout safely than a shallow, swift water, with little in the way of cover or security to offer.

Whatever the type of water, the general procedure is approximately the same. Having got as near to the distribution-point as possible, the lorry stops and the tank-covers are removed. Baths of various sizes, according to the number and size of the trout, are filled with water from the fish-tanks. Trout are then netted out into the bath, or baths, according to the number of helpers. Commonly enough, only one receptacle is used. Care is taken not to overcrowd the bath with trout, since they have got to stand up to a 'carry' of variable distance and duration. When carrying long distances, the bath is only lightly loaded with trout, unless the course followed is close to the waterside so that fresh water can be obtained from time to time. On fairly short carries of 100 yards or less, several hundred yearlings or, perhaps, 50 two-year-olds can be put into one bath. Before putting them into the water, care should be taken to see that there is no appreciable discrepancy in the temperature of the tank-water and the water of the stream or lake into which they are going. It is usual to mix, thoroughly, the water in the bath, with fresh water poured from a bucket as slowly as possible, so as not to equalize the temperature too rapidly. The driver of the lorry—who in these days is quite likely to be a director or partner of the firm concerned—will usually carry a thermometer for checking temperatures. Normally there is little time wasted in equalizing the temperature, but if there is a variation of more than 5 degrees F. care should be taken and equalization should be more prolonged. Some lorries carry portable petrol-pumps so that thorough mixing can take place in the fish-tank, but this method can only be used where the vehicle can get sufficiently near to the waterside for the suction-pipe from the pump to reach.

While a lot is often said about temperature equalization, many people are inclined to exaggerate its importance. After many years' experience, I have never known any trouble arise as a result of differences in temperature. Nevertheless, precautions should be taken, particularly, as indicated above, when the variation is more than 5 degrees F. The best delivery-tanks are insulated with cork chips or slag wool, so that even on hot days the water remains within a degree or so of the starting temperature.

Troubles during distribution are rare, though sometimes it be can an exhausting business for the helpers, particularly when big trout have to be carried for long distances over rough ground. The chief danger is that the water in the baths will overheat, or that the oxygen in the water will be consumed. Casualties, nevertheless, are uncommon. As the trout-farmer expects to replace or allow for any casualties free of charge, he will invariably put himself to any amount of trouble rather than allow anything untoward to occur.

Notable Deliveries. The delivery of trout over long distances by road, and their subsequent distribution, requires physical endurance of a high order. The present writer does not claim to be exceptional in this respect, but few ordinary mortals would relish this work and it would be quite taboo for trade-union members.

The longest run I, personally, have ever done was on Wednesday, March 15th, 1950. The following extract from my diary gives the details : 'Up at 3.0 a.m. and got loaded by 5.0 a.m. to leave for Milsom near Tenbury in Worcestershire. Arrived there at 9.0 a.m., an hour before schedule. Luckily the two keepers were about and we soon got the 50 12-inch Brown Trout into the Lake. After draining-off the small tank, I was on the move again by 9.45 a.m. and went on to Tenbury; then made for Leominster and on through Hay to Brecon. On to the A.40 and through Carmarthen and so to Haverfordwest, which I reached by 2.30 p.m. Met Lord Milford at Picton Castle. He immediately came along with me to his lake, though I was not due until 4 p.m. We put 250 5-inch, 100 8-inch and 1,000 Brown Trout Fry into the lake. Back home via Brecon, Abergavenny, Monmouth, Gloucester and Cricklade, getting in at 1.0 a.m. Total mileage : 412.'

Another interesting run commenced at midnight on Thursday, October 26th, 1950, when with 10,000 yearlings on board and a driver with me we started for the Eden in Cumberland. Arrived at Bawtry for breakfast. Turning off the Great North Road at Scotch Corner we got on to the A.66 for Brough, Appleby and Penrith. We reached our destination—Holm Wrangle Farm, about 2 miles from Armathwaite—exactly on time at 3.0 p.m. The fish travelled perfectly and we only had two casualties out of 10,000 and those were crushed when netting them out of the tanks. On the following day we started for home at 8.30 a.m. and arrived at exactly 8.30 p.m., the total mileage for both directions being 608. This run was repeated, though I did not go myself, on October 17th, 1951, with equal success.

There have been many other runs of a similar nature and doubtless my contemporaries have equalled or exceeded such performances. I have only mentioned them to show that nothing short of devotion to the work and unflagging energy can make long-distance deliveries of trout reliable, or, indeed, possible at all. During the height of the delivery season, anyone in charge of a trout-delivery vehicle does more than a full day's work. If he does not go to bed dog-tired, it is only because he is used to the life and would not willingly exchange it for any other.

Oxygen tanks for distribution of trout: The use of an auxiliary supply of oxygen in fish tanks enables trout to be carried with safety over long distances, provided that the tanks are not overloaded and that the necessary amount of oxygen is continuously supplied. Oxygen is fed in through fine porous diffusing elements at low pressure, usually from 2½—5 p.s.i. according to the load and the temperature of the water. The following table shows the quantity of trout which can be carried with safety in tanks of suitable design up to temperatures of 65 degrees F.

Loading Table for 400-gallon Oxygen Tank.

Size of Trout	*Maximum number of Trout*
4″	12,000
5″	6,400
6″	3,460
7″	2,790
8″	1,590
9″	1,085
10″	900
11″	705
12″	521
13″	426
14″	336
15″	279

This table is largely based on the weight of trout per gallon of water. Theoretically it should be possible to carry considerably larger numbers of small trout of 6-inches and under than shown in the table. For some reason, not fully understood, it is not possible to load such heavy weights in the case of small trout and it is necessary in practice to reduce the weight by about one-third.

The amount of oxygen consumed by trout will depend on their size and the temperature of the water. A considerably larger amount of oxygen has to be supplied than the theoretical requirements, owing to the fact that a proportion of the oxygen fed through the diffusers is not absorbed by the water.

The table given below shows the actual consumption of oxygen of trout of various sizes at different temperatures :

Consumption of Oxygen per Hour in Cubic Feet per 1,000 Trout at varying temperatures.

Size of Trout	*Water temperature in degrees Fahr.*		
	40	50	60
	Oxygen consumption in cu/ft. per hour.		
3″	0.022	0.04	0.05
5″	0.095	0.175	0.21
7″	0.28	0.52	0.63
9″	0.62	1.15	1.37
11″	1.19	2.2	2.63
13″	1.96	3.62	4.33
15″	2.96	5.47	6.54

Containers sent by rail are self-aerating *as long as they remain in motion.* When standing, however, the oxygen in the water is rapidly used up. Hence the importance of a reliable service with the shortest possible waits at junctions and prompt collection at the home station. These containers hold about 14 gallons of water and their full load of trout is 7 lbs. The safe standing time is given in the table below :

14-gallon containers holding 7-lbs. of Trout.

Temperature of water degrees F.	*Safe standing time in minutes.*
40	46
45	28
50	20
55	16
60	14
65	12

From this it is quite clear why it is safer to send trout by rail only during the colder months of the year.

Statistics on Stocking with Trout. I have written a considerable amount about trout stocking in previous pages. I have gone so far as to condemn certain practices and recommend others. Some readers may, however, be interested to have definite information of the size and number of trout ordered by different owners for different types of water in various parts of the country.

Figures given in the following tables detail 100 consecutive consignments from a well-known trout farm in England, showing into which waters the trout went, for what purpose they were wanted and the number and size of the trout delivered.

100 Consecutive Consignments.

Number	*Area*	*Type of Water*	*Use*	*Number of Trout*	*Size*
1	Devon	R. Dart	Private	200	8-9″
2	Bucks.	R. Chess	Syndicate	1000	6″
				250	10″
				12	2-lb.
				50	7″ Rbs.
				50	12″ Rbs.
3	Derby	Lake	Club	10	2-3 lb.
				400	13-14″
4	Surrey	R. Wey	Club	100	13″
				300	12″
				50	11″ Rbs.
5	Berks.	Lake	Private	50	11-13″
		Stream	Private	200	6″
6	Wilts.	Stream	Club	4000	2-m-fry
7	Notts.	R. Greet	Club	500	6″
				100	12″
8	Notts.	Dover Beck	Private	100	9-10″
9	Notts.	Dover Beck	Private	100	9-10″
10	Derby	Ecclesbourne	Club	100	9-10″
11	Herts.	Trout Farm	Commercial	30000	Rb. fry
12	Derby	Lake	Club	300	13-14″
				40	2-3 lb.
13	Leics.	R. Sence	Club	300	11-13″
				125	11-13″ Rbs.
14	Wilts.	Stream	Private	250	3″
15	Herts.	Trout Farm	Commercial	30000	Rb. fry
16	Hants.	R. Wey	Club	250	6″
				250	9″
17	Leics.	R. Sence	Club	300	11-13″
				125	11-13″ Rbs.
18	Surrey	Tillingbourne	Syndicate	250	11″
19	Glos.	R. Coln	Private	150	11-12″
20	Glos.	R. Coln	Hotel	50	12″
				25	15″
21	Hants.	R. Itchen	Private	400	10″
22	Yorks.	Driffield Beck	Club	380	12″
				7	3-lb.
23	Yorks.	Scalby Beck	Club	250	6″
24	Hants.	R. Itchen	Rod-letting	350	13″
25	Essex	Fish Farm	Commercial	100	12″
				50	6-8″
26	Oxon.	R. Windrush	Club	500	7-9″
27	Berks.	Lambourne	Private	100	10-11″
28	Oxon.	Stream	Private	250	8″
29	Beds.	Stream	Private	1000	2-m-fry
30	Herts.	R. Beane	Syndicate	375	10″
				160	11″
				100	10″ Rbs.

Number	Area	Type of Water	Use	of Trout Number	Size
31	Dorset	R. Frome	Private	1000	5″
32	Dorset	Lake	Private	50	5″
33	Surrey	R. Mole	Club	200	11″
34	Hereford	R. Arrow	Private	250	11½-12″
35	Kent	Lake	Private	100	6-7″ Rbs.
36	Bucks.	Lake	Private	100	8″
37	Hants.	R. Whitewater	Syndicate	50	14″
38	Hants.	R. Whitewater	Hotel	50	12″
39	Berks.	R. Kennet	Rod-letting	1000	6″
				250	11-13″
40	Mddx.	R. Colne	Club	400	12″
				25	2-lb.
41	Cornwall	Reservoir	Tickets	1000	6″
42	Norfolk	Trout Farm	Commercial	200	13″
43	Bucks.	Stream	Syndicate	50	11″
				25	12″
				12	14″
44	Berks.	R. Kennet	Private	250	12″
45	Berks.	R. Kennet	Private	100	13″
46	Hereford	R. Arrow	Private	180	12-13″
				20	12-13″ Rbs.
47	Berks.	R. Kennet	Private	50	2-3 lb.
48	Wilts.	R. Wylye	Club	12800	3-m-fry
49	Herts.	Lake	Private	200	7″
				200	7″ Rbs.
50	Herts.	R. Gade	Rod-letting	25	12″
				100	12″ Rbs.
51	Hants.	R. Test	Private	500	5″
52	Hants.	R. Test	Rod-letting	50	14″
53	Hants.	R. Anton	Private	100	8″ Rbs.
54	Bucks.	R. Misbourne	Private	100	10-12″
55	Norfolk	Trout Farm	Commercial	250	12″
56	Hants.	R. Test	Private	300	12″
57	Berks.	Gravel-pit	Private	100	12″
				10	3-4 lb.
				250	3-m-fry
58	Hants.	R. Test	Private	100	13″
59	Essex	Fish Farm	Commercial	100	6″
60	Berks.	R. Enborne	Syndicate	400	4-5″
61	Norfolk	Trout Farm	Commercial	100	12″
62	Herts.	R. Beane	Syndicate	500	7″
63	Hants.	R. Whitewater	Private	400	6″
				100	6″ Rbs.
				1000	4-m-fry
64	Hants.	R. Whitewater	Private	100	13″
65	Berks.	R. Kennet	Private	1000	6″
				250	11″
66	Berks.	R. Kennet	Private	50	12″
				50	12″ Rbs.

Trout and Trout Waters

Number	*Area*	*Type of Water*	*Use*	*Number of Trout*	*Size*
67	Somerset	Lake	Private	25	12″
				50	6″
68	Wilts.	Lake	Rod-letting	460	12″
				15	3-lb.
69	Glos.	R. Churn	Syndicate	50	13″
				50	10″
				25	11″
70	Hants.	R. Dever	Private	100	5″
71	Wilts.	R. Avon	Club	3000	4-m-fry
72	Wilts.	R. Wylye	Private	250	4″
				100	8″
				1000	2-m-fry
73	Berks.	Lake	Club	200	12″ Rbs.
74	Herts.	R. Lea	Club	100	12″
75	Devon	Reservoir	Tickets	1000	3″
76	Berks.	R. Pang	Private	100	4″
				500	4-m-fry
				500	4-m-Rb. fry
77	Mddx.	R. Colne	Club	200	12″
				15	2-4 lb.
78	Hants.	R. Test	Private	300	7-8½″
79	Essex	Fish Farm	Commercial	200	7″
				25	4″
80	Hants.	R. Test	Private	250	6″
81	Yorks.	R. Rye	Club	350	10″
				1900	4-m-fry
82	Yorks.	R. Derwent	Club	2000	3-m-fry
83	Oxon.	R. Windrush	Club	250	9-11″
84	Hants.	R. Test	Private	50	13-15″
85	Berks.	R. Pang	Private	100	4″
86	Berks.	R. Lambourne	Club	100	10″
87	Beds.	Pond	Private	35	10″
88	Wilts.	Lake	Private	150	3″
89	Beds.	Gravel-pit	Private	150	10″
90	Cornwall	Reservoir	Tickets	1000	6″
				1000	8″
91	Somerset	Quarry-pond	Private	500	9″
92	Bucks.	Lake	Syndicate	1000	6″
93	C'berl'd	Trout Farm	Commercial	10000	2½-3″
94	Hunts.	Pond	Private	100	5″
				200	3″ Rbs.
95	Berks.	R. Kennet	Rod-letting	200	14-16″
96	North'ts.	Reservoir	Tickets	1000	8″
97	Yorks.	R. Wharfe	Club	10000	Ova
98	Yorks.	R. Wharfe	Club	10000	Ova
99	Glos.	Trout Farm	Commercial	25000	Ova
100	Yorks.	R. Wharfe	Club	1000	Rb. Ova

Note : 'Rb.' or 'Rbs.' is an abbreviation for Rainbow Trout.

Counties served by 100 consecutive consignments.

Devonshire	2
Buckinghamshire	5
Derbyshire	3
Surrey	3
Berkshire	15
Wiltshire	7
Nottinghamshire	3
Hertfordshire	7
Leicestershire	2
Hampshire	16
Gloucestershire	4
Yorkshire	7
Essex	3
Oxfordshire	3
Bedfordshire	3
Dorset	2
Herefordshire	2
Kent	1
Middlesex	2
Cornwall	2
Norfolk	3
Somerset	2
Cumberland	1
Huntingdonshire	1
Northamptonshire	1
	100

NOTE: Some consignments were delivered on the same day by the same vehicle. A few went by train or were collected from the trout farm.

Types of water served by 100 consecutive consignments.

Rivers and Streams	70
Lakes and Ponds	14
Fish Farms	10
Reservoirs	4
Gravel-pits	2
Quarry-ponds	1
	101

NOTE: In the case of one delivery, a stream and a lake on the same property were stocked, thus bringing the total to 101 instead of 100.

Use made of waters served by 100 consecutive consignments.

Private	43
Clubs	26
Fish Farms	10
Rod-letting	6
Syndicates	9
Tickets	4
Hotels	2
	100

Sizes and quantities of trout supplied in 100 consecutive consignments.

RAINBOW TROUT

Ova	1,000
Fry	60,500
3″	200
6″	100
6-7″	100
7″	250
8″	100
10″	100
11″	50
12″	400
11-13″	250
12-13″	20

BROWN TROUT

Ova	45,000
2-months-fed fry	6,000
3-months-fed fry	15,050
4-months-fed fry	6,400
2½-3″	10,000
3″	1,400
4″	475
4-5″	400
5″	1,750
6″	8,000
6-8″	50
7″	900
7-8½″	300
7-9″	500
8″	2,450
8-9″	200
9″	750
9-10″	300
9-11″	500
10″	1,710
10-11″	100
10-12″	100
11″	1,035
11-13″	900
11½-12″	250
12″	3,265
12-13″	180
13″	1,000
13-14″	700
13-15″	50
14″	112
14-16″	200
15″	25
2-lb. av.	37
2-3 lbs.	100
3-lbs.	22
2-4 lbs.	15
3-4 lbs.	10

Different age-groups ordered by 100 consecutive purchasers.

Brown Trout ova only	3
Rainbow ova only	1
Brown Trout Fry only	5
Brown Trout Fry, Rainbow Fry and Brown Trout yearlings	1
Brown Trout Fry and 2-year-old Brown Trout	1
Brown Trout Fry, Brown Trout yearlings and Brown Trout 2-year-olds	1
Rainbow Fry only	2
Brown Trout Fry, 3-year-old Brown Trout and Large Brown Trout	1
Brown Trout yearlings only	17
Brown Trout yearlings and 2 two-year-olds ; Rainbow yearlings and 2-year-olds	1
Yearling Brown Trout and 3-year-old Brown Trout	5
Yearling Brown Trout and 2-year-old Brown Trout	3
Rainbow yearlings only	3
Brown Trout yearlings and Rainbow yearlings	1
Brown Trout 2-year-olds only	18
Brown Trout 2-year-olds and Brown Trout 3-year-olds	1
Brown Trout 2-year-olds and Large Brown Trout	1
Brown Trout 2-year-olds and Rainbow 2-year-olds	2
Brown Trout 3-year-olds only	21
Brown Trout 3-year-olds and Large Brown Trout	5
Brown Trout 3-year-olds and Rainbow 2-year-olds	6
Large Brown Trout only	1
	100

N.B.—The term 'large brown trout' means, in this case, fish of 1½ lbs. upwards.

Conclusions (among others) to be drawn from above statistics.

(i) That trout are spread widely over a large area, but that most districts do much less stocking than most anglers would imagine.

(ii) That river and stream stockings predominate, accounting for 70 per cent. of the deliveries during the period (1951) concerned.

(iii) Private waters are still in a majority, accounting for 43 per cent. of the total. Clubs account for 26 per cent. and, including clubs, 47 per cent. of the waters are commercialised in one way or another.

(iv) That sales of Rainbow Trout for stocking are much less than those for Brown Trout.

(v) That purchasers of Brown Trout between them purchased 40 different sizes out of 100 consignments.

(vi) That trout fry were purchased by 12 per cent. of customers.
That yearlings were purchased by 32 per cent. of customers.
That two-year-olds were purchased by 30 per cent. of customers.
That three-year-olds were purchased by 39 per cent. of customers.
That large trout (1½ lbs. upwards) were purchased by 4 per cent. of customers.

N.B.—Many of these customers bought several sizes at the same time.

CHAPTER 7

On Fishing Management

What does the average angler want? The average angler wants, above all, four things. He wants fishing within fairly easy reach of his home, so that he can get away to fish without too much trouble or expense in reaching the water. He wants fishing conditions to be quiet and restful and not too overcrowded. He wants his fishing as cheap as possible. Finally—and most important—he wants to catch plenty of trout of good average size, with as many big ones as possible thrown in.

It is only fair to record that the average angler does not possess—and it is unlikely that he will—all of these desirable things.

He is lucky if he does not have to travel a considerable distance for his fishing. He will not be an average angler if the water he fishes is not subjected to a considerable amount of 'flogging' by numbers of other average anglers. If his fishing is cheap, it is almost certain to be heavily fished; the trout in the water are unlikely to be over-numerous; very few will be recorded in pounds rather than in ounces.

The average angler, if I have diagnosed his status correctly, is a member of an over-crowded fishing-club, whose subscribers are certainly counted by the score, possibly by the hundred. Owing to the distance of the town or city from the club's waters, fishing may only be possible during the week-end. His major expenses are transport, to and from the water, and fishing-tackle; lesser expenses include a fishing-licence obtainable for a few shillings from his River Board and a subscription, also measured in shillings, payable to his club. For his expenditure he probably expects to catch many more trout than will, in fact, come his way. The reason for this may be that the stock of native trout has virtually ceased to exist; trout that might otherwise have bred and replaced themselves have, in the main, already gone into the angler's bag; the River Board may make an attempt to alleviate the situation by stocking; his club may do the same; but the money available is usually quite inadequate to do much good. Money spent on stocking the waters of large clubs will frequently only buy a few trout per angler if they are small, while, if they are anywhere near takeable size, the angler may only get a fraction of a trout as his share.

The main reasons for the average angler's discomfiture are largely as follows:

(i) His water is being fished too hard in relation to the water's natural productivity. The water cannot grow enough trout to take care of the wastage due to fishing; those trout that are bred in the water do not get time to grow.

(ii) He and his fellow-anglers have been living for too long on capital in terms of trout-flesh. On many waters that capital is virtually expended.

(iii) While he may appreciate the fact that stocking in some form is essential, he is either unwilling, or incapable, of paying for it on an adequate scale.

What is the remedy for this dilemma? The remedy, or remedies, are simply prescribed, but far less simply made effective. The following alternatives, or a combination of several of them, are available to those who direct the affairs of the club to which the average angler belongs:

(i) To reduce membership so that the water is less heavily fished.

(ii) To increase subscriptions so that more money is available for stocking.

(iii) To make quite certain that money, already being expended by the club, is wisely and effectively spent. Economies in certain directions may often be possible. Money spent on stocking is often largely wasted, owing to the wrong age or size of trout being turned in.

(iv) Reducing the number of trout that are killed annually.

(v) Controlling vermin more effectively; improving conditions for natural breeding; increasing the food-supply. In other words: more efficient keepering.

The last thing intended in this chapter is to make any claim that it pretends to be a thorough study of the subject of river management.

The reader will probably know of a number of books on this subject. Others, who may be interested, are referred to the bibliography at the end of this book.

The object of this chapter is to bring forward information not contained elsewhere and, at the same time, to clarify a few of the points on which advice from existing sources is obscure, ambiguous, or contradictory.

Partly for convenience and partly owing to the difficulty of keeping these notes down to a reasonable length, I have arranged the material in alphabetical order.

Access. Anyone renting or buying fishing should make quite certain that rights of way are defined in his lease or conveyance. This is particularly necessary in the case of isolated lakes or ponds, or where one bank only of a stream or river is involved. If this precaution is omitted, difficulties can easily arise later on, as, for instance, if some change of ownership affecting the situation should occur. It is essential, at times, to get along both banks of a river for keepering purposes and I know of several cases where the refusal of the owner of the opposite bank to permit access has caused great inconvenience. When a water is leased, the tenant should make it clear that anyone authorized to fish by him must also have access to the water. Club waters are often let in the name of perhaps only one person, whereas, actually, a considerable number of persons may be involved.

Algae, Control of. During the period from spring to autumn, a considerable number of letters reach my office asking for advice about checking or preventing the formation of algae (usually described as 'scum', 'blanket-weed', 'flannel-weed' or 'slime') from all kinds of water. A great deal has been written about this subject, various remedies being suggested. Algae can certainly be checked and killed by a number of chemicals. Copper sulphate is often used for this purpose, but it is very dangerous to trout and, in most waters, a concentration lethal to trout is necessary to do more than temporarily check the algae. The minimum strength likely to be any use is about 0.5 parts per million and, unless very careful and thorough mixing takes place, lethal concentrations considerably in excess of 1.0 p.p.m. are almost certain to occur. (The only time I have ever used copper sulphate for killing algae in a water, I killed trout I did not know were present). Bleaching powder, ozone and creosote have also been used, while there are several proprietary chemicals for curing algal growths in swimming-baths.

In my view, it is impossible satisfactorily to prevent algal growths in trout waters ; nor is it desirable. Every organism living in water is directly or indirectly dependent upon algae for its food-supply. If a water is so pure that it cannot grow algae, it is unlikely to be much, if any, value for trout fishing. Waters fertilized by sewage matter tend to grow heavier amounts of algae than unpolluted waters, but the algae help in the purification of the water by releasing oxygen.

In spite of the necessity for algal production—unless the water is to be very barren from the fishing point of view—these growths, if heavy and reaching the surface, are of considerable annoyance to anglers and can, at times, make fishing impossible. I would say, however, that satisfactory control is not a practical proposition. The worst cases occur in sluggish, shallow streams, or ponds. The deeper the water and the more shaded it is from light, the less will algae form in these unwelcome masses.

Dredging shallow waters, in order to increase the depth may, therefore, be of considerable advantage, though the cost may easily be a deterrent. When making artificial lakes and ponds, particularly in areas where the water is hard and otherwise rich in nutrient matter, a reasonable balance between deep and shallow water should be achieved. Food production will be highest in water of 4 feet, or less ; but production of algae will also be greatest at these depths. Water exceeding 6 feet in depth rarely becomes 'smothered up' with algae, yet food-production is reasonably good. Little algae will form on the bottom at depths exceeding 10 feet. My own idea of the optimum depth of ponds and lakes for trout, is one ranging from 5—12 feet.

Anglers, Types of. Even among trout-fishermen there are a number of different types, many of whom will hold very divergent views about methods of fishing, the ideal type of water, methods of stocking, weed-cutting, size-limits and, indeed, about every subject on which it is possible for there to be more than one opinion. This does not tend to make life any easier for club secretaries and others concerned with the running of trout fishing. Where a definite policy has been adopted by a particular fishery, it is obviously an advantage to acquire members likely to fit in with that policy ; at the same time, any existing members, whose views differ violently from those of the secretary or his committee, might conceivably enjoy themselves more on some other fishery.

Agricultural Interests. Since the interests of farmers, millers, riverside dwellers and villagers, will rarely perfectly coincide with those of the angler, it is obviously important for anglers, club secretaries and all concerned, to narrow the range of conflict as much as possible.

Farmers dislike having gates left open, fences rendered ineffective, people taking short-cuts across their fields, parked cars blocking tracks for their carts and tractors, fishermen's wives and children wandering round the farmyard as if it belonged to them. Anglers, for their part, often resent the water being persistently muddied by cattle, ducks paddling disturbingly about, surreptitious poaching by farm-hands, untethered bulls and a long list of other occasional inconveniences and annoyances.

Millers do not usually regard the angler with any particular affection. Both are interested in a commodity common enough in general, but rare and precious under certain conditions and at certain seasons. I refer, naturally, to water. The miller sees in the flow, so many horsepower to drive his mill. The angler is interested in it only as a home for trout.

Villagers and other rural dwellers frequently appear to resent the presence of the angler. In many cases, this is due to the fact that they, themselves, are prevented by notice-boards, keepers and other means, from getting along the riverside themselves. The objection seems to me a natural one. Nevertheless, it is possible by the exercise of tact, forbearance and diplomacy, to go a long way towards reconciling all these conflicting interests. It is also worth remembering that all these people make much better friends than foes and that the fishing is liable to suffer unless friendly relations can be established and maintained.

Bottom Feeders. Elsewhere in this book I have written something about non-rising trout. It is, of course, perfectly natural for a trout to feed mainly on sub-aqueous food. The vast bulk of food available to trout is, after all, permanently below the surface. Only at those times when floating food is sufficiently plentiful—at certain seasons in the year and at certain times of the day—is it worth their while to expend the necessary energy involved in feeding at the surface.

Nevertheless, I believe that some strains of trout are less prone to rise than others; that the free-risers are caught soonest, leaving behind a larger proportion of trout with inhibitions about taking flies at the surface at all; that a certain times of the year, notably in July and August, sub-aqueous food is so plentiful that trout can feed adequately without rising. At the same time, I believe that regular stocking with artificially-reared trout —most of which are very free risers—can materially alter the situation; also that slightly heavier weed-cutting in many waters, particularly during July and August, may be helpful in tempting trout to the surface, provided it is done with some care and discrimination.

Bank Repairs. Sooner or later the owner or tenant of almost every pond and lake and many stretches of river (particularly mill ponds) is likely to be faced with the problem and expense of repairs to banks. Leaks can be serious, causing a lowering of the water-level and the escape of fish. Many methods of repair have been adopted from time to time. To my mind, camp-sheeting and piling in wood is unsatisfactory. In about 15 years the timber perishes and further repairs have to be done. Apart from that, the cost is now a great deterrent. Chalk, another popular material for bank repairs, has never appeared to me to be very reliable and often needs timber camp-sheeting to stop it from ravelling down. Steel interlocking piling is ideal for repairs to lake banks and, indeed, any position where there may be a considerable head of water. Once driven, they are more or less everlasting. A great advantage of steel piling is that repairs can be carried out without reducing the head of water. With most other methods, complete reduction of the head is usually essential if the work is to be of any lasting value. Unfortunately, their use is now not only prohibitive as regards cost, but extreme difficulty in obtaining supplies would be inevitable. Bags (preferably army sandbags, owing to their handy size) filled with dry cement and gravel, previously mixed, and laid in rows to form a wall, make permanent, effective and not-too-costly repairs. I have had personal experience in the use of thousands of concrete bags for repairs to banks and have no hesitation in recording that no repairs done in this way have ever had to have subsequent attention, many having been laid as long ago as 25 years and showing every indication of lasting for much longer than another 25 years. In some situations their cost is not justified and I have, quite recently, started using a material new to me, but which, so far, has proved extremely successful. This is puddled (or 'pugged') clay. Ordinary clay, dug straight from the ground, has often previously been used with success, but there is a great deal of labour involved in digging and carrying it to the site of the work. An extensive and troublesome blow in the bank of a 10-ft. deep pond caused me to look around for a considerable amount of material that would not be too expensive and, at the same time, economical with labour. The outcome was an introduction to 'pugged' clay. This came from a nearby brickworks in loads of 4 cu/yds. at a time, at a cost of £5 per load. I had expected great gobbets of clay of all shapes and sizes and was agreeably surprised to find that it was in blocks of uniform size, measuring 9-inches x 9-inches x 4½-inches. This is three times the size of a brick. The clay is passed through a machine at the brickworks, which compresses it and cuts it off to the required dimensions. With the aid of this clay, dumped within a few yards of the site, we were able, with a very limited amount of labour, to make a strong and absolutely watertight job of the bank at a very reasonable overall cost.

Boards, River. The new River Boards, replacing the former Fishery Boards, have not been operating long enough for it to be clear whether angling interests are likely to suffer or to be enhanced. The representation of fishery interests on these boards is small and likely, perhaps, to be minimized where other interests are more powerfully represented. In some districts the activities of the Boards are sure to be more vigorous and effective than in others. Some have poor material to work with in the form of badly polluted waters in heavily populated districts. Some Boards are more fortunately placed in this respect.

Anglers are primarily interested in clean water : water that is not only clean, but productive in terms of fish-food and fish. From recently published information it would appear that the new Boards have in fact, less, rather than more power, than the old Fishery Boards, in the matter of checking pollution.

Anglers are also interested in what they get—and what they think they ought to get—from the money they pay to the Boards for fishing licences. Most of them think that the River Boards should provide more fish. In some areas the Boards do distribute a limited number of trout and other fish reared by themselves. In all parts of the country they could render a service to the angler by purchasing the surplus stocks of trout from trout-farms. Hardly a year goes by without these surpluses occuring and, needless to say, the trout-farmer would infinitely prefer to sell his surplus cheaply to the River Boards rather than send them dead to market, or be compelled to feed them back to his remaining stock because they are too small to be saleable to hotels and restaurants.

Cannibals. I am convinced that the trout is one of the worst, if not the worst, enemies of his own kind. A 1-lb. cannibal trout—and all trout are cannibals if given the chance—can easily consume 100—150 trout fry in a day. I think it is significant that most of the failures in stocking with fry and small yearlings occur in waters where trout are already reasonably numerous. In a previous note, I have suggested that the very heavy casualty-rate among trout-fry may, conceivably, be a provision of nature for the conversion of minute food organisms into a form (viz. the fry itself) readily assimilated by larger trout, which would otherwise, in many waters, find food extremely hard to come by during the first few months of the year. In any event, any small trout is liable to be consumed by any other trout more than about two-and-a-half times his own length. Even trout-fry (from the same parents) cannibalize one another before reaching an age of three months; though cannibalism among trout-fry doubtless occurs far more widely in hatcheries than at large. In 1951 I turned about 90,000 trout-fry into a small stream possessing a good current and dense cover in the form of a luxuriant growth of water celery. There were also numbers of wild trout up to about 1½-lbs. in weight. These trout were very busy for some weeks, obviously hunting the fry. For some time after the fry were put in, it was possible to take a fine-meshed net and sweep up half-a-dozen at a dip. By midsummer it was impossible to catch a fry at all. There were no coarse fish; very few pike; an occasional kingfisher; in fact almost nothing in the way of vermin except larger trout.

Chain-scythe. For many years it has been fashionable to decry the use of the chain-scythe for weed-cutting. Almost every deficiency in the quality of a fishery—deficiencies in trout, food and fly—have at various times been blamed to the use of the chain-scythe. No doubt there is a great deal in it, too. On the other hand, the disparagement of the chain-scythe has, undoubtedly, gone too far. Actually, in many fair-sized rivers, carrying heavy crops of weed (for example, the Kennet, Avon, Test and Itchen) the chain-scythe is about the only sensible tool to use. Apart from the cost of more finnicky methods, such as the use of hand-scythes and pole-scythes, the time involved is so great that it is well-nigh impossible to keep pace with the growth of weed. On shallows and small streams, hand-scythes can, of course, be used to great advantage.

Coarse Fish. As already emphasized, coarse fish and trout are not good mixers. Some coarse fish, notably pike and perch, are predatory. Others consume quite a large proportion of animal food when it is sufficiently small and, consequently, compete with trout for food, in many cases, all too successfully. In many lakes and reservoirs, fished only for trout, coarse fish are present in immense numbers and it is a matter for wonder that trout are able to subsist at all. The truth is, of course, that more effective control of the coarse fish would greatly improve the productive capacity of the particular water as a trout fishery.

Dams. Dams on ponds and lakes should always be constructed so that provision is made for draining-off the water periodically. Where this provision is omitted—all that is needed is a simple penstock or sluice and a suitable gradient on the bottom—the subsequent control of fish in the water is made infinitely more difficult. For example, coarse fish can be kept down to a minimum by draining-off every two or three years ; at the same time, aged trout can also be removed.

Many small streams and rivers can be made more attractive to trout, by increasing the depth by a series of fixed or removable dams. Trout will remain in very shallow water only if they can find no deeper water and the holding-capacity of a stream will be considerably improved by breaking up shallow water into pools of greater depth. Various materials may be used and most writers on fishery management have described the several types of dam in some detail. Concrete bags are, perhaps, the strongest, though dams made from wire-netting or logs are often cheaper and quite useful as temporary structures.

A dam at the top and bottom of any stretch of water lending itself to damming is, no doubt, quite an appreciable deterrent to the passage of fish of all kinds. A dam at the lower boundary is a distinct discouragement to coarse fish. How often is it noticeable that below a dam a river is teeming with coarse fish, yet above it—assuming it is an adequate obstacle—coarse fish are absent.

Where trout-stocking is practised, dams are likely to assist in the retention of fish that might otherwise run out of that particular stretch into deeper water.

Dredging. Many harsh words have been written and spoken about the activities of drainage authorities and others operating dredgers. While many streams can be ruined by dredging—they are readily converted from trout streams into paradises for chub, dace and other coarse fish—there is no doubt that there is plenty of scope for the dredger in this country today, in connection with the improvement of trout waters.

Hundreds of ponds and lakes up and down the country are so full of mud and so overgrown with rushes and other marginal herbage, that they are useless—except perhaps in one or two areas of deeper water—for trout fishing, or, indeed, any other kind of fishing. The cost of such work will usually fall on the owner, since it is of no advantage to Catchment or Drainage Boards to pull mud from waters of this type, and, not surprisingly, the removal and spreading of mud from large lakes can seldom be contemplated unless some return for the expense is in view. Since, however, a badly silted lake is of no value at all and the value of a lake of sufficient depth and size to develop as trout-fishing may be considerable, it may easily be worth while going into the matter carefully. Even the high cost of dredging will, undoubtedly, be very much less than the cost of making a lake of similar depth and area from scratch. As most estates are now run on a commercial basis, it is usually possible to charge the cost of dredging to the 'Repairs Account': a very different matter from paying for it privately. I know of two fairly recent cases, where large sheets of water were dredged, both being paid for out of gross income with the sanction of the Inland Revenue Department. Both of these waters were subsequently stocked with trout and show promise of being assets in the years ahead.

Many mill pounds are badly silted and, when in that condition, they are of little value. Cleared of mud, they again become the favourite haunts of the largest trout. There is more hope of getting mill pounds dredged at public expense, since badly silted reaches of river may be a cause of flooding, real or imaginary. The Thames Conservancy Board has done much useful work in its large area, though it has harmed many small streams by dredging out gravel to lower the levels. No one who has had a muddy mill pound dredged, entirely free of charge,—and not only dredged, but the mud spread and sown with grass-seed—can remain ungrateful.

Expenses. Some waters are much more expensive to run than others. In the south of England—particularly on the chalk-streams—costs are now so high that, in my view, anglers are not paying enough for their rods, adequately to compensate the owners. As already indicated in a previous chapter, keepering, rates, repairs and other overheads absorb a very large part of the angler's subscription. While the owner probably feels that he is charging the minimum amount to his rods, the rods may, possibly, feel that they are paying too much in relation to the amount of sport obtained. It seems to me that by charging more, and providing more trout, both the angler and the owner would be better satisfied.

As an example, two keepers on a length of fishing will absorb about £70 of subscription from each of 10 rods. Other expenses may easily account for another £30 apiece and then, perhaps, with no provision for stocking. (Only today, before retyping this chapter, I have been looking over a stretch of chalk-stream where five rods are paying £100 each. So far they have done no stocking. Their bag last season was under 100 trout and each trout cost them rather more than £5). In my view, the fishery owner is in a somewhat similar position in relation to the angler, as the farmer is to the townsman. The townsman wants cheap food at the farmer's expense. The angler wants his fishing as cheaply as possible. The day is undoubtedly coming when the townsman will have to pay more for his food or go without ; while the angler—not only on the chalk-streams, but all over Britain—will have to pay more for his fishing, or be satisfied with sport on a gradually diminishing scale.

Electrical Fishing. In Germany, Norway and several other continental countries, electrical apparatus for catching fish has been in use for a number of years. Electrical methods, particularly for sampling fish populations, have also been widely used in the United States. This country has lagged behind, but during the last year or two several clubs and individuals have done valuable pioneering work. The chief use likely to be made of electrical apparatus over here is for ridding trout-waters of coarse fish. My own experience of electrical methods is negligible, apart from several small experiments which were inconclusive. From what I have read about the technique—and a considerable amount has already been published, particularly by the Fish and Wildlife Service in Washington, D.C.—I had been led to believe that its use would be very limited as regards the width and depth of water with which it would deal. However, recent opportunity to watch apparatus owned by the Piscatorial Society in use has convinced me that the electrical control of coarse fish is here to stay and that within a few years it will largely replace netting, except on deep, wide rivers and lakes. In a few hours I watched Col. Hammond-Davies, who devised the apparatus, take some thousands of coarse fish—barbel, chub, dace, gudgeon, perch, pike and minnows—from water which it would have been almost impossible to net successfully. At the same time, many tiny coarse fish, which would have passed through the meshes of any ordinary net, were captured. Casualties were surprisingly few and certainly less than normally experienced when netting.

Even so, there is a good deal yet to be learned ; for example, the ideal voltage, the best type and size of electrode, ways of increasing the range of the apparatus, its effect on trout, insects and shrimps and other details. At present, I believe, research is being conducted by the Ministry of Agriculture and Fisheries and the Freshwater Biological Association, while information is being co-ordinated by the Electrical Research Council. Their report is certain to be of great interest and value.

Electrical Fish Screens. In America, electrical barrages have been used to induce salmon to enter fish passes and also as a means of keeping them from entering turbines. How successful these methods are I am not in a position to judge. It does seem to me quite certain, however, that it would be possible to use electricity for controlling the upstream movements of trout on streams and small rivers, by having suitably shaped electrodes permanently sited in the water. These electrodes would have to be fixed in solid housings on each bank, so that fish could not get round the back of them. Fish coming into the magnetic field between the electrodes would turn over and drift back. This method would probably only work in preventing fish from moving upstream, since fish coming down into the field would be turned over and float below the screen. The consumption of electricity might be a deterrent. The minimum power required for a stream 30 feet wide would be at least 2kW and to be fully effective twice as much power might well be desirable. Research in this direction would be useful, as it is certain that any type of electrical fish-screen that would work and not be prohibitive in running costs would be favourably received by many owners of water difficult or impossible to screen in other ways.

Fish do not get time to grow. One of the most difficult problems for many rod-letting fisheries and clubs is to provide adequate sport for the angler and, at the same time, to have sufficient young stock coming along to provide fishing in subsequent years.

Nine or ten-inch two-year-olds are frequently used for stocking waters with a twelve or thirteen-inch size limit in force. Unfortunately, numbers of these small fish get caught long before they are up to size ; others get eaten by pike, herons and other vermin. The most satisfactory remedy is probably to stock with larger fish. For example, the cost of 12-inch trout is about 50 per cent. higher than 10-inch. As, however, the 10-inch fish will usually take a year to come up to 12-inches and a loss of 50 per cent. or more might easily occur during that time by migration up and down stream, losses by vermin and undersized fish damaged by anglers, while the catch of 12-inch fish should rarely be less than 75 per cent. and may exceed 95 per cent., the larger, more expensive fish are often cheaper in the long-run.

The provision of trout of takeable size is one of the main headaches of those responsible for controlling most of our heavily-fished waters and, in waters of this type, small-fish stocking is seldom a success.

Fences. Many owners of fishing have to maintain fencing in order to keep cattle from getting into the water and from treading down the banks. I have acute personal memories of many hours spent driving hundreds of fencing-posts and straining miles of barbed wire. Apart from the cost, there is nothing more abominable than barbed-wire fences along a river, but fencing of some kind is, unfortunately, often essential. Sometimes the farmers are responsible for the fencing ; but frequently it is the liability of the fishing-tenant. I am glad to say that I am no longer in the position of having to cope with fences. If I did have to run fences again, I should certainly try out an electric-fencer. While an electric-fence is not infallible, it should serve every purpose for keeping cattle reasonably clear of river banks and be very much cheaper and less objectionable into the bargain.

Food supply, Improving. Almost every author of a book on fishing has devoted considerable space to ways of improving the food-supply, namely aquatic fauna of a type edible by trout. While it is certain that any improvement that can be made will be most valuable, it is equally certain that most efforts in this direction are quite inadequate and, in the main, largely inffective. Attempts at the acclimatization of species hitherto lacking are, occasionally, rewarded with success. Most biologists will probably agree with me, however, that where any particular species is absent, there is usually some environmental deficiency to account for it. For example, it is useless to try and introduce fast water species of *ephemeroptera* to slow water and vice versa. Alkaline-loving animals will not live in acid water ; nor will creatures adapted for deep water live in shallow. In brief, in waters of appreciable age (all natural streams and lakes) the fauna present is only present because the local conditions are agreeable to it. While most trout-farmers sell various kinds of natural food for increasing the food-supply, some are at pains to advise prospective customers that the net improvement in the food-supply is likely to be trifling.

On the other hand, great success often results from introduction of natural food to freshly filled reservoirs, artificial lakes and ponds and waters that have dried up, or been denuded by a pollution, subsequently removed. There is also considerable evidence from past customers, who not infrequently have attributed increases in hatches of fly to earlier purchases of fly ova or larvae, though such increases may well, in reality, have been mainly due to seasonal fluctuations.

The best line for any owner of water, anxious to improve the food-supply, is to make a careful survey of it (or have one made) and discover which creatures are the most plentiful and which form the staple food of trout. He can then, assuming he knows something about the life histories of the animals concerned, possibly increase the numbers of these predominating types, by bringing about improvements in their environment.

I have, for example, a very vivid memory of how the whole flora and fauna of a small stream in the south of England was completely changed by the erection of a dam and the removal of a considerable number of trees. Prior to the construction of the dam, the stream contained nothing but ribbon-weed (Sparganium) and the food-supply was very sparse. By cutting timber to let in more light, putting in the dam to increase the depth and planting some celery and ranunculus at the upper end, the whole character of the stream was quickly changed for the better. In a few years almost all the ribbon-weed had disappeared, being largely displaced by celery, though ranunculus took hold in the faster portions. Food—snails, shrimp and fly-larvae—previously scarce, became extremely plentiful and the trout, formerly rather lanky, became fat and lusty. It is almost certain that dumping in quantities of snails, shrimps and fly larvae with the stream in its original condition would have met with little or no success.

It is, therefore, always wise to concentrate on types of trout food likely to find the particular environment agreeable to them. Desirable types, unsuited to the environment as it is, are only likely to succeed if conditions can so be altered as to come within their range of tolerance.

Facts, Recording. Records of all kinds are useful, provided that they are accurate. Most events in connection with the running of trout fisheries are well worth recording and club secretaries cannot be urged too strongly that an annual report, based on a well-kept diary of day-to-day events, will be interesting to members and reassuring to the secretary himself. It will include such items of interest as stocking details, notes about hatches of fly, results of netting, weed-cutting, the general state of the river, notes about hatches of fly, number of trout caught, their average weight, who caught the most and heaviest fish, and so forth. Some members—usually those well down the list of averages—may think that this report is an utter waste of money and that the secretary is in cahoot with the printer into the bargain. It is very comforting to be able to refer to the report for such-and-such a year when an argument, about how good, or how bad, it was, gets under way. As a class, anglers not only have very frail memories, but many are deliberately (or unintentionally) 'cussed" into the bargain. This is readily illustrated by the way in which a poor season is sometimes looked back upon, five years later, as a red-letter year, simply because someone has forgotten how badly he actually did ; or is anxious to create the impression that the fishing is steadily going to pot. In brief, records are great instruments for deflating windbags.

Fertilizing Trout Waters. Absolutely pure water will not grow fish. Natural waters contain, in varying quantities, dissolved chemicals which are necessary for the establishment and survival of plant life, itself necessary for supporting animal life. Waters deficient in elements such as calcium, nitrogen, phosphorus and potassium will be less productive than waters containing an adequate supply.

In some countries, notably in the United States, where much research in this direction has been carried out, considerable use of chemical fertilizers for improving fish-pond production is habitually made. Research has also been done in this country notably by the Freshwater Biological Association. See also, for more recent information, reports by 'Brown Trout Research' at Pitlochry.

Less spectacular results are likely, when apply fertilizer to British trout waters, than in the fertilization of bass-ponds in America. The process, in the latter case, derives an immense advantage, in that, increasing the fertility encourages the growth of plankton, this being consumed by bluegill sunfish (or some other 'forage' fish), these, in turn, being eaten by the predatory bass. Millions of plankton organisms are consumed by thousands of 'forage' fish, while the 'forage' fish are devoured by hundreds of bass. As there is no satisfactory 'forage' fish that can be used in conjunction with trout, the advantage of fertilizer in the case of trout waters is largely limited to an increase in the growth of staple food-organisms like shrimps and snails. The use of fertilizers is also mainly confined to closed ponds and lakes. Where there is any considerable flow of water, the wastage of fertilizer is too heavy to enable it economically to be applied. The greatest scope, for improving trout waters in Great Britain by means of fertilizers, would appear to be mainly confined to barren tarns and lochs of the soft water, acid type. Raising the alkalinity by the application of powdered chalk in amounts ranging from 5 to 100 cwt. per acre, has, in some waters, achieved appreciable success. Other materials used are sodium nitrate, superphosphate, basic slag, muriate of potash and finely ground limestone.

Grass-cutting. It is usual, at any rate in the south of England, to keep the banks of lakes and rivers reasonably well trimmed during the summer, leaving an uncut margin to provide cover. While this saves anglers a great deal of energy and discomfort in ploughing their way through wet grass and stinging-nettles, there is no doubt that it involves a great deal of labour and expense and is, in these times, something of a luxury.

Where the ground is reasonably level and free from obstructions and side-ditches, considerable economy can be made by using a motor-scythe, of which there are now several excellent types. A three-foot wide swath can be cut at a slow walking pace and an energetic man can cut several miles of river bank in a day. In my own case, with some miles of stream and pond banks to cut, I believe it would now be impossible to cope with the grass-cutting, but for the employment of one of these excellent machines.

Hatcheries. Far fewer clubs and private owners now operate trout hatcheries than, say, forty years ago. Quite definitely, small-scale trout-hatching is not an economical process. Apart from the cost of the equipment, a considerable amount of labour is involved, particularly in the form of frequent visits to see that everything is all right. Unless this work can be carried out voluntarily by members, the cost is likely to be out of all proportion to the value of the resulting fry, though there may be some excuse for those who wish to retain their own local strain of trout. In other cases, alevins and unfed fry can be purchased so cheaply from trout-farms that a private hatchery is quite unnecessary and far more expensive. As already indicated elsewhere, the survival-rate of fry in most waters already containing trout is negligible. Unless the whole of the run of spawning trout on a stream could be trapped and stripped, and the ova incubated, no measurable increase in the numbers of fish reaching maturity would be in the least likely. It is certain that nearly all small-scale hatchery work, apart from its interest and educational value, is largely wasted.

Keepers. While a keeper is an essential on many waters and work could often be found for half-a-dozen on numerous southern stretches of river, where herbage and weed-growth is particularly luxuriant, there is no doubt that a keeper today is a great expense. It is, therefore, extremely desirable that any keeper employed should be prepared to do a full day's work. Every member of a fishing club, syndicate, or rod-letting water, where one or more keepers are employed, is paying out a very large slice of his subscription in the form of wages. While there are some keepers who regard their job along the riverside as a kind of rest-cure (and the fishing would be no worse and infinitely cheaper without them), many of them are, in fact, extremely hard-working and may, in these days, be trying to do the work of two men, owing to reductions in staff. The ideal keeper is, of course, one who will get things done without any word from higher authority, whereas some keepers will not do anything today that can well be left until tomorrow and others will not do at all, anything that they can decently avoid. If I have any real criticism of keepers—and really this is the angler's fault—it is that many of them are too prone to waste time wandering round nursemaiding fishermen unable to discover a feeding fish on their own. With wages at £7—£8 per week, this is a luxury that any angler should be willing to forego.

Limit, Size. Nearly all association, club and rod-letting fisheries impose some sort of limit on the size of trout anglers are permitted to kill. The primary object of this is to lessen the slaughter of small fish and, at the same time, to leave an adequate stock at the end of the season to provide sport during the following year. There are many different ways of applying these size limits and limits on numbers of fish that may be retained. Personally, I am opposed to the common practice of returning undersized fish, unless they have been lightly hooked, quickly landed and speedily released. It is certain that, during warm weather, a high percentage of trout returned by anglers die as a result of the rough handling received. It seems to me preferable, in every way, to have a simple 'number limit' irrespective of size. At the same time, once they have caught their limit, anglers should cease fishing for that day. A few clubs do impose a rule of this nature and, in my view, it is one to be copied more widely, the effect being to deter anglers from fishing for small trout and to encourage them to seek out the best possible fish. The rule is much easier to apply on chalk-streams and some other waters fished with the dry-fly, since, with experience, a very fair estimate of the size of every fish cast at can usually be made. On lochs and wet-fly streams, there does not appear to be any obvious way out of the difficulty and the practice of returning undersized trout will probably have to continue.

Methods, Labour-saving. The circumstances of our times, have made it necessary for almost all human enterprises to be examined critically, with a view to discovering ways of economizing in time and labour. The running of trout fisheries should be no exception and any implement, or technique, that will enable one man to do the work of two without undue loss of efficiency is worthy of consideration. There are probably very few waters so efficiently run that some economy in time and labour could not be made. Farmers are rapidly learning that it is unprofitable to have buildings and equipment haphazardly arranged. It is expensive to pay men for walking long distances between jobs and the provision of some means of transport is desirable. The same should apply to keepers. A man who has to walk a couple of miles twice a day to clean a screen, or adjust a hatch, is going to waste a considerable amount of time. He will also waste time if, for example, materials for repair work have to be laboriously wheeled by barrow for a mile or two, necessitating many journeys, when it is possible to dump the material by lorry, or, perhaps, to provide a large punt capable of carrying a ton or more in one trip. There are, in fact, scores of ways in which labour can be reduced, but intimate knowledge of the particular work is usually a great advantage in thinking out practical methods of economy. Most keepers could probably suggest numerous ways in which they could make more use of their time, but unless there is some tangible inducement for them to increase their usefulness, all but the best are unlikely to be co-operative.

Membership. An important decision for those forming new fishing clubs is how to regulate the number of members. From many points of view, the more limited the membership the better. Fishing conditions will be less crowded, more use can be made of the natural capacity of the water as a trout-producer and the average sport enjoyed is likely to be higher. On the other hand, the cost per rod will be higher too. The ideal figure is likely to be arrived at, after consideration of the sum of money likely to be required to run the fishing and to provide a particular number of takeable trout. Having decided this—suppose, for example, the total estimated cost is £500—the person or persons forming the club must immediately fix the maximum membership. It is not possible, in fairness to members, to 'play about' with the membership total. A man, offered a rod on a water on the understanding that there would be nine other people fishing, would have every reason to show his displeasure if, when the season opens, he discovers that there are, in fact, nineteen. Fixing the number of rods will automatically fix the cost per rod. To do this so that members will be happy, that resignations will be few and that, if there are resignations new members will be found, involves a considerable amount of knowledge and experience. The ideal figure would probably be arrived at by careful consideration of the following points :

(i) The natural quality of the water ; its length, area and special features.

(ii) Its geographical situation ; and its distance from potential rods.

(iii) The level of sport likely to be achieved for the money to be expended.

The argument might go, for example, something like this : 'My water will not produce big fish, nor is it suitable for big-fish stocking. I am rather off the map and cannot expect to get rods at very high subscriptions. The fishing won't compare with waters where rods are paying £50 per annum. It's certain I could not get 10 rods at £50 apiece. On the other hand, I've got a nice long stretch, it's lovely country, and if I can offer 20 rods at £25 each I should stand a very good chance of filling-up.'

Netting. Where conditions are sufficiently favourable—snags and obstructions few, current, depth and other factors suitable—netting is an invaluable method of controlling coarse fish in trout waters. In most cases, more time spent in preliminary work, making clear places for pulling out the nets, and getting the bottom as clean as possible, would be beneficial and result in greater efficiency. In the majority of cases the number of fish escaping the nets is certainly more than what are caught. Very small coarse fish—which eventually grow—pass through the meshes of the nets, however well they are operated. The cost of nets is high. The cost of working, cleaning, drying and repairing them is also high. Nets do not last for ever. Other methods, such as draining-off, trapping, electrical fishing, should also be considered.

Secretaries. I take off my hat to all club secretaries. At best it is a thankless job ; at worst like sitting on top of a powder-barrel. Anyone who possesses the doubtful distinction of being Honorary Secretary of a trout-club will agree wholeheartedly with me that the first day of the close season is the most blissful day in the year. Provided he possesses a keeper who will let him walk along the river without shadowing him like a detective—some keepers have all sorts of funny inhibitions about the functions of secretaries—he feels that the river is his for the first time for six months. But now old Colonel Bloggins and the others who made life hell for him during the fishing-season, have all cleared off. From what some of them said by way of farewell he may, incidentally, have to try and find some new members before next spring ; though if he has been Hon. Sec. for a season or two, he will have learned that the man who excels at fault-finding and threatens resignation most, will hang on to his ticket like a leech. In fact, unless he is able to catch this gentlemen flogging an Alexandra down the Broad Water in contravention of his Committee's Rule No. 5, this self-appointed secretarial scourge will be with him for ever.

The secretary has certainly earned his end-of-season stroll. Not a sign of a member anywhere. Nothing but an old imprint of his pet aversion's great boots on a mudbank to remind him that the blighter ever existed. Trout rising everywhere, too : good 'uns some of them. Rather remarkable, that ! Only a week ago he'd been told, in no uncertain terms, that there were no trout and no fly. Perhaps he is momentarily puzzled that so many of them are 'standing up' so boldly, sipping down spinner as if they loved 'em. Then he concludes, usually correctly, that it simply is not true that all the flies have deserted his river ; it is not true that any trout, conceivably present, are bottom-feeders ; it is not true that this river is hopelessly fished-out. Jubilantly, therefore, the secretary goes on his way ; and who will deny him his jubilance? A few more thoughtful than the rest, may even think of writing to thank him for an enjoyable season's fishing.

Stocking. Having already written a whole chapter on this subject, I will write no more, except to repeat that on most club, syndicate and rod-letting fisheries, stocking is usually the key to success. Any stocking done should, however, be designed to aim at a certain level of results. Haphazard stocking with trout, regardless of all the numerous factors that will probably need to be considered, will often be a costly failure.

Screens. Except in the case of lakes and ponds with small inflow and outflow, screens are likely to be expensive to install. They also consume a great deal of labour. To justify the cost of installation and the labour involved in keeping them free from rubbish, they must be capable of retaining at least an equivalent value in trout. Since trout, if given the freedom of a river, are likely to move in both directions, a screen, in certain situations, may easily prevent fish from entering a given stretch, as well as stopping others from leaving it. Before installing fish-screens (other than in ponds and lakes, where they are often an asset), it is advisable to look a good deal further up and downstream than the particular stretch concerned.

It will often be found that a screen is likely to be less valuable than previously imagined. There may, for instance, be other obstacles, such as weirs or mill dams, which will effectively prevent the loss of trout at no trouble or expense.

Tickets, Short-term. While day and weekly tickets are popular with fishermen, they are usually unprofitable for owners of fishing. Anglers coming to fish on a day-ticket invariably fish hard all day and, if the water is any good, will probably catch some trout. If a day-ticket holder paying £1 for a day's fishing has anything of a day, he will certainly take away far more than £1-worth of trout. A water relying on stocking for providing sport for day and other short-term tickets will almost certainly find that charges are too low to be profitable. The average season-ticket holder, paying, say £100 for his rod, may not fish more than 20 times during the season. I have known rods pay £50 and never come at all. Unless no stocking is done (or at any rate, stocking with anything larger than yearlings) I cannot see how short-term tickets can be let at the rates sometimes charged, failing a highly productive water and one capable of standing up to continual flogging day after day. Few waters are in that category, needless to say.

Trees. Trees play an important part on most trout fisheries. They provide shade and shelter for the angler, cover for the trout. They provide a sanctuary for flies that might otherwise be blown-off and lost to the water. Trees can be overdone, however. Too much big timber along a river is a continual source of trouble and expense, hampering weed-cutting, netting, and absorbing labour for lopping and pulling fallen branches out of the water. When planting trees, consideration should be given to the most suitable species—alders are very good—and they should be carefully sited. It is also desirable to visualize them twenty or thirty years onward.

Traps, Fish. Fish traps are often invaluable in fishery work, for assisting in the control of pike and other coarse fish. They are also useful for catching up trout from side-streams and enabling them to be returned to the main river. Fish traps—usually more elaborate than the simple wire traps of a portable type in common use—are also most valuable for catching spawning trout in waters where private hatcheries are operated.

Vermin, Control of. I have little to write here on this subject, except to mention that furred, feathered and scaled vermin undoubtedly account for millions of trout every year. It is probably true to say that if pollution could be completely eliminated and vermin eradicated there would be ten times as much fishing-room for anglers as there is at present and sport would be infinitely better. It is difficult to say which particular creature is the most damaging. Much will depend on the area and the type of water, while different ages and sizes of trout are more vulnerable to some creatures than to others. Herons are my particular aversion and it is quite laughable to me to read some of the letters in the angling press protesting their innocence. Having lost unknown thousands of trout down the rapacious throats of herons, over the years, I am not prepared to listen to arguments in their favour. Incidentally, I have recently found that electrified fencing is a satisfactory means of keeping them from taking trout from fish ponds. It is, of course, troublesome to erect and must be kept free from grass and at just the right height.

On any fishing, the control of vermin will probably pay bigger dividends in terms of improved sport than anything else that can be done.

Weed-cutting. Weed-cutting is an almost perennial topic among fishermen. Few anglers are capable of agreement on how much weed should be cut and how much should be left. If anything, I am inclined to fancy that opinions are loaded rather too heavily in favour of doing as little weed-cutting as possible. Doubtless this is due to the efforts of almost every author on river management for the past thirty years. It seems to me that, on some waters particularly the luxuriantly-weeded waters of southern England, that more, rather than less, cutting might sometimes be advantageous. On most waters, trout rise freely in the spring. They rise freely because fly is most plentiful then and other forms of food are less abundant than later in the year. In July and August the balance is in favour of sub-aqueous food. Trout are sometimes so jaded by then, and anglers so disgusted, that the situation is taken as it is found. Things slack off. The weed reaches the surface and trout, even if they wished, would often have some difficulty in putting their noses up through it. Perhaps there is no good reason why they should ; they are being catered for quite adequately down below. Experiments made in this connection, tend to show that heavier weed-cutting in the second half of the season will create in the trout a more lively interest in surface food. At the same time, anything approaching wholesale removal of weed should be avoided.

On some fisheries, weed-cutting is a very expensive matter : hence the tendency to reduce it to the minimum. The burden falls most heavily, where the weed also has to be pulled out. Removal of cut weed takes, on average, four or five times as much labour as that involved in cutting it. Some years before the war, I advocated the use of special hatches for drawing-off cut weed on to waste ground. Where feasible, this will save a tremendous amount of labour.

Recently I have seen a small elevator, driven by a petrol-engine, used to good purpose by Thames Conservancy men, when weed-cutting on the Kennet. Weed-cutting boats have also been used, though power-driven boats do not compete favourably with a chain-scythe worked by an adequate gang of men.

Yield, Annual. To most fishermen, the yardstick by which fishing in various waters is compared, is the annual yield of trout. It is the annual bag of trout that attracts anglers to a water from another not so fortunate.

Maintaining the annual yield of trout—indeed to prevent it from declining—is the major problem confronting every trout fishery in this country today. That problem has to be faced, in conjunction with many factors of a practical and economic nature.

While I do not pretend to have solved any of these difficulties in foregoing pages, I may, perhaps, have done something towards showing that these difficulties are very real and that trout-fishing will only be maintained in the face of advancing civilization at continually rising cost and artificiality.

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